THE ENGINEER

MAY 21, 1954

Institution of Electrical Engineers' Annual Report

AT the annual general meeting of the Institution of Electrical Engineers on May 20th, the council presented its report for the year ended March 31, 1954. The report indicated that, "though the growth of membership since the war has been maintained and though there has been a continued increase in the number of graduates, the elections and transfers to this class are not adequate to meet the country's needs for professionally qualified electrical engineers." In its efforts to encourage adequate recruitment to the profession of electrical engineering, and in view of the importance of an early grounding in science as part of an entrant's secondary education, the council supported a conference called by the Federation of British Industries to discuss the provision of science masters in schools. With the Ministry of Education, the council is also collaborating in efforts to obtain full development of "the middle stream of technological education" with particular regard to the provision of works-based sandwich courses in electrical engineering. Some of the problems of recruitment are implicit in figures published in appendices to the report. For example, during the year under review the total numbers of members and associate members increased by 134 and 907 respectively; the number of graduates increased by 360, but the number of students fell by 730. In the same period the corporate membership increased by 1041 to a record figure of 19,552, while the number of non-corporate members declined to 18,944, compared with 19,272 in 1953 and 19,496 in 1952. It is clear from the report that, although the total membership has been increasing annually, the rate of annual increase has fallen (from 2493 in 1945 to 1464 in 1949, 1010 in 1951 and 714 in 1954), and that the present rate is inadequate to support a growing industry. Other matters included in the council's report are a review of the institution's meetings and other activities, including technical investigations and joint work with other bodies.

Institution of Engineers-in-Charge Dinner

THE Institution of Engineers-in-Charge held its forty-ninth annual dinner at the Holborn Restaurant, London, last Friday evening. The president, Sir William Stanier, F.R.S., was in the chair, and a large company of members and their guests attended. The toast of "The Institution" was proposed by Mr. H. A. R. Binney, Director of the British Standards Institution, who said, in the course of his speech, that sometimes to-day there seemed to be a tendency to put security before efficiency. This country, Mr. Binney continued, now relied more than ever for its livelihood upon the efforts of engineers, and it was quite certain that engineers could not go ahead without efficiency. The high standard of the Institution's membership demonstrated that its aim was to encourage engineers-in-charge to become more efficient. In his response to the toast, Sir William Stanier said that the Institution of Engineers-in-Charge filled an important place in the scheme of things as it brought together people engaged in the practical side of engineering. Modern craftsmen, Sir William urged, needed to increase their technical knowledge, and it was to that end that the Institution worked. The toast of "The Guests" was proposed by Mr. R. L. Quertier, a vice-president of the Institution, the response to it being made by Major-General C. Lloyd, Director of the Department of Technology, City and Guilds of London Institute. Major-General Lloyd mentioned that at present there were about 400,000 students in technical colleges throughout the Commonwealth who were taking City and Guilds courses. The final toast of the evening was that of "The President." It was felicitously proposed by Mr. A. T. Penn, the Institution's deputy honorary secretary, and enthusiastically acclaimed.

Dickinson Memorial Lecture

ON Wednesday evening of last week, a well-attended meeting of the Newcomen Society was held at the Science Museum, at which Dr. Charles Singer delivered the first Dickinson Memorial Lecture. The lecture has been instituted to commemorate the life and work of Dr. Henry Winram Dickinson, M.I.Mech.E., who was a founder member of the Newcomen Society, and for over thirty years its indefatigable honorary secretary. Dr. Singer, who was president of the International Congress of the History of Science and Technology which was held in London in 1931, appropriately entitled his lecture "The Happy Scholar." In the course of it, he not only

dealt appreciatively with many aspects of Dr. Dickinson's work, but he also emphasised the educational value of technological history. The memorial lectures are to be given at intervals of two years, and each lecturer is to receive a Dickinson memorial medal. The first presentation was thus made to Dr. Singer by the president of the Newcomen Society, Mr. Rex Wailes, M.I.Mech.E. The medal, of 2½in diameter, has been struck in bronze; its design is illustrated herewith. Dr. Dickinson, who until his retirement in 1930 was keeper of the mechanical engineering collections at the Science Museum, was a frequent contributor to our columns. A lengthy series of articles from his pen, entitled "Water Supply of Greater London," which appeared in THE ENGINEER during 1948, is to be republished in July by the Newcomen Society as a memorial volume. The work is a historical account of the development of London's water supply from the earliest known sources in the thirteenth century to the present mid-century.

International Conference on Large Electric Systems

THE fifteenth International Conference on Large Electric Systems (C.I.G.R.E.) opened in Paris on Wednesday, May 12th, and the final session will be held to-morrow. Delegates from thirty-three countries, including Germany, Hungary, and the U.S.S.R. are attending the conference. More than 125 papers are being presented for discussion at the technical sessions of the conference. Last week the subjects discussed included alternators, insulating material, insulators, substations, circuit breakers, transformers, teletransmission and interference. On Sunday delegates had the choice of excursions to Deauville beach or to the Loire Chateaux. The technical sessions of the conference were resumed on Monday, May 17th, when the topics under discussion were extra-high-voltage overhead lines, cables, surges and lighting and high-voltage d.c. transmission. On Wednesday there were two technical visits, the first, to the research and testing laboratory of Electricité de France, which has been described in these columns, and the second to the central laboratory which was opened in 1949 for the service of the electrical industry, and is responsible for housing the national physical standards and for carrying out precise physical measurements. Thursday's discussions were concerned with relays and overhead line towers. To-day's programme covers system stability and overhead lines and the closing ceremony will be held to-morrow morning.

Hydraulic Research in 1953

THE annual report of the Hydraulic Research Board of the D.S.I.R. and of the Director of Hydraulic Research has just been published by H.M. Stationery Office. Progress was recorded in the construction of the research station, a part of the main hall of which is expected to be in use early in 1955. A second wave basin came into use in the summer. Tidal model investigation of the River Wyre was completed during the year, after experiments had demonstrated the effects of various kinds of deflec ing spur on stabilising the low-water channel. Work on the large tidal model of the Thames showed that the heavy silting which is a major problem in the tidal basin at Tilbury could be greatly reduced by the construction of a training wall and a jetty. The pilot model of the Thames was used to study the effect of an upland flood run-off coinciding with a storm surge such as occurred on January 31–February 1, 1953. It was found that an increase of 9in in the level at London Bridge would result under these conditions. Immediately after the 1953 storm surge two survey teams were sent out from the station to inspect damage on the East Coast and collect data. The station also started research into certain aspects of reclamation in the Wash. Other hydraulic model experiments in progress in 1953 included some preliminary work to a general study of a flood relief scheme for part of the River Severn, and construction of a model of Southwold harbour to investigate wave action and associated problems. A pilot model of the Severn estuary is now in operation; its primary object is to ascertain the seaward limits of the proposed large model, which will be used for investigations of the Severn Barrage. Good progress was made during the year with investigations on a model of Lyttelton Harbour, New Zealand, and an investigation was made to confirm a theoretical design for a wave excluder for the discharge channel of a new power station in Cyprus. Other work in progress in 1953 included the collection of data on coast erosion and the development of a miniature current meter.

CONSTRUCTION OF CASTILETTO DAM, MARMORERA HYDRO-ELECTRIC SCHEME, SWITZERLAND

Fig. 16—Castiletto dam from upstream showing rock facing and entrance portal of diversion tunnel on right bank

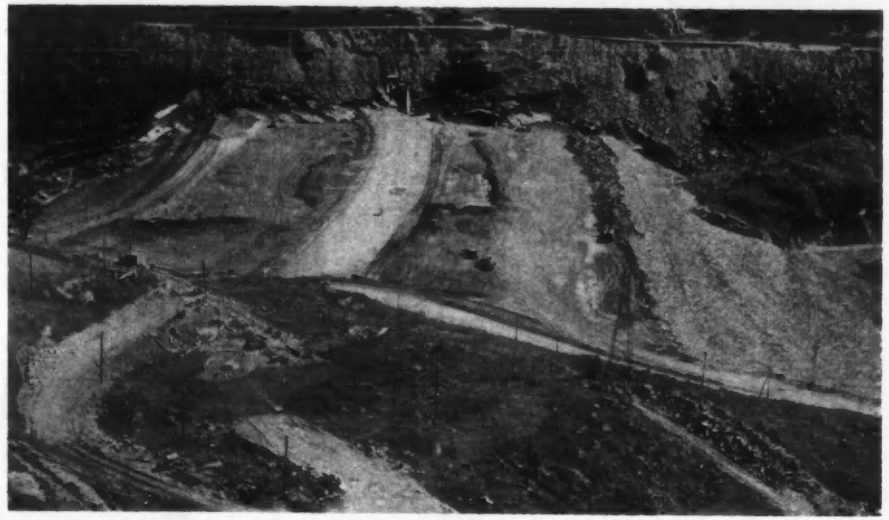


Fig. 17—Constructional work in progress at Castiletto dam. The rock facing on the upstream side and the clay core filter material may be discerned

Fig. 18—Emplacement of clay core material of dam

Fig. 19—Constructional plant placing earth fill on downstream side of dam

Some Recent Swiss Hydro-Electric Schemes

No. V—(*Continued from page* 701, *May* 14*th*)

The earth-fill dam of the Marmorera hydro-electric scheme (Castiletto dam) is the first large-scale structure of its kind to be built in Switzerland. A power station of 46*MW installed capacity forms part of the scheme, giving an estimated annual production of* 156 *million kWh, about half of which will be in the winter period. The reservoir will also allow an increase of* 60,000,000*kWh in the winter generation of the older power stations in the catchment.*

THE Marmorera reservoir, which is at present under construction on the Julia River in Eastern Switzerland (Graubünden), is noteworthy for the fact that a major earth-fill dam is being built there. The dam will have a height of some 80m and will form a reservoir with a capacity of 60,000,000 cubic metres (about 48,600 acre-feet), draining a catchment 135 square kilometres in extent, with an annual yield of some 168 million cubic metres of water, about 20 per cent of which is winter flow.

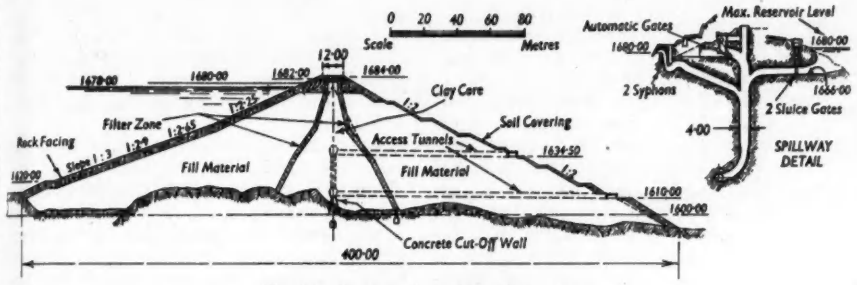


Fig. 20—Cross section of Castiletto dam

Earth or rock-fill dams of any size have not been built before in Switzerland, although a second dam of this kind is planned for a site near Göschenen and it is expected that construction will start this year. The dam at Marmorera is based on American practice, although, of course, the design and construction is entirely in Swiss hands. Details of the dam are shown in the various illustrations accompanying this article. The site was not suitable for a concrete dam because of a considerable deposit of clay and unsound rock in the left bank, formed by the weathering of serpentine. This area is clearly shown in Fig. 21 ; it has been sealed by the construction of a cut-off trench. The dam itself consists of a clay core, with filter layers on each side of it, and, outside the filter layers, the principal filling material.

The upstream slope has a layer of large rocks to give the usual protection from waves, &c., on the water side, and the downstream berms and slopes are being soiled and planted with grass.

The dam was designed with a factor of safety of 1·5 under the worst conditions. The grading limits for the three materials, core, filter and fill, are shown in Fig. 22. The clay core—a moraine clay—is made about equal in width to the hydrostatic head of the reservoir at any given depth ; the density/water content curve for the clay is shown in Fig. 23. In practice it is placed in position with a water content of between 80 and 90 per cent in layers 15cm thick, and compacted with sheepsfoot rollers. The filter material as excavated has a water content of 12 to 18 per cent, but at that value it is too soft to support the heavy constructional plant, so it is placed with a water content of 9 to 12 per cent, giving its maximum density. The fill for the rest of the dam is consolidated with water jets, and by the inevitable movement over it of the plant—dumpers, bulldozers, and so on—but it is not rolled with sheepsfoot rollers or tamped. It is placed in layers 1m thick. Fig. 20 shows the extra thickness of rock-fill dumped at the heel of the dam, where it is founded on a pocket of clay and peat ; it was also necessary to flatten out the slopes of the dam near the left bank, where the zone of weathered serpentine was approached. The behaviour of this zone under the influence of the water level of the reservoir was to some extent uncertain, so that precaution was taken to ensure stability on the left bank.

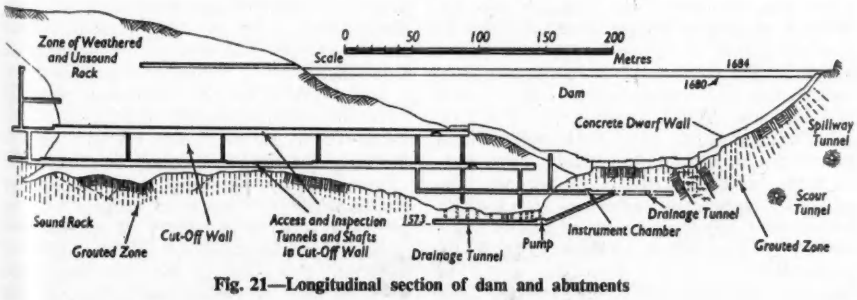


Fig. 21—Longitudinal section of dam and abutments

There is a soil mechanics laboratory at the site where the grading, density and water content of the clay core and filter layers, and sometimes the grading of the fill itself are checked. The apparatus in the laboratory includes a machine for unconfined compression tests of large samples of material ; tests are also being carried out on the infiltration of the clay core material through the filter layers.

The material for the fill is excavated from an extensive deposit of scree on the left bank, a short distance upstream from the dam. After excavation, which may involve blasting, it is taken to one of two large hoppers, above which is a grillage of steel beams, spaced so that oversize material may be rejected, collected in a separate hopper, and then used for facing the upstream slope. From these two hoppers the material is again taken, in heavy steel-bodied trucks or " Tournapulls," and dumped at the river bank. A bulldozer then pushes it into the river, where the strong current removes the finer material, thus bringing the grading to within the limits shown in Fig. 22. The removal of the smaller sizes is an essential part of the work, as it allows considerable permeability and hence an even distribution of pore pressure on the upstream side of the dam. The washed material is recovered from the river bed by one of two chain-bucket excavators, and then taken by truck to the dam for emplacement.

Material for the filter layer is excavated further upstream from a deposit of moraine. It is screened to reject oversize material and then passes through a drying oven, so that its water content may be reduced to the required value of 9 to 12 per cent. From there it passes on a belt conveyor to a covered storage area, from which it is taken as required to the dam site.

The clay is also dug from the moraine, at a deposit some distance upstream from the dam. Water may be added to it if it is too dry, but otherwise it is taken straight to the dam and placed in position. Oversize stones are then picked out by hand.

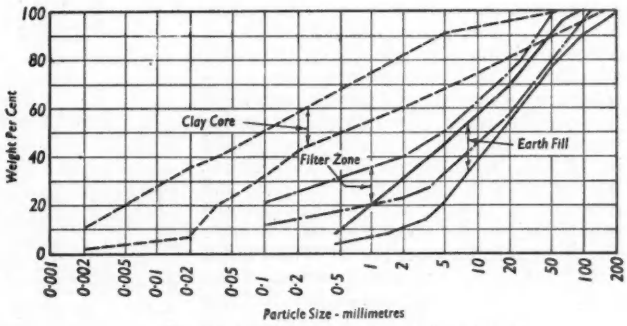


Fig. 22—Grading curves of materials of dam

Such work is even more vulnerable to winter weather than concreting, and in fact it is only possible to place the clay core when the ground is free from frost during the period May–October. There is, however, a powerful installation of constructional plant with about thirty-three " Euclids " or similar heavy trucks or " Tournapulls," and some thirteen bulldozers and twelve excavators at work on the site. The dam is being built at a rate of some 9000 cubic metres placed daily.

Work started at the site in 1950, and it is estimated that the dam will be completed this year, when the total volume of fill—2,600,000 cubic metres—will all be in position. The photographs reproduced in Figs. 16 to 19, show the progress made last

summer and give an idea of the plant employed and the nature of the site.

The Cut-off Wall

An important part of the work at the dam site has been the construction of the concrete cut-off wall to seal off the bad area on the left bank. This wall extends for a distance of 400m and to a maximum depth of 104m below the crest of the dam. The wall is of cellular construction. It is 2·1m wide and was built in 1m steps ; a trench 1m deep was dug below the last completed section of the wall, which was then concreted to form cellular compartments 3·3m square, with side and cross walls 0·3m thick. Another trench was then dug below the newly placed concrete, the procedure being repeated until the desired depth was reached. At one place, where conditions were particularly bad, steel sheet piles had to be driven to construct the wall. Two rows of piling were driven from within the narrow width of the trench, braced with steel beams, and later the space between them was filled with concrete. Grouting, up to a pressure of twenty atmospheres, was carried out from the bottom of the cellular wall. The system of access tunnels shown in Fig. 21 was left incorporated in the wall, but otherwise the hollow spaces were filled with concrete to complete the construction. On the left bank side the wall is built up to the crest level of the dam. The longitudinal section, Fig. 21, shows where it ends close to the deepest section of the dam, and how it joins with a low concrete wall, built right across to the right bank crest in the centre of the clay core. The purpose of this second wall (shown in the background of Fig. 18) is to prevent the formation of a seepage path at the junction of the clay core and the rock.

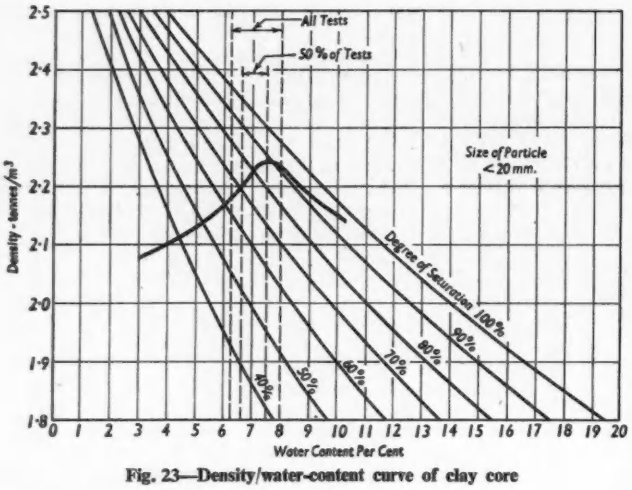


Fig. 23—Density/water-content curve of clay core

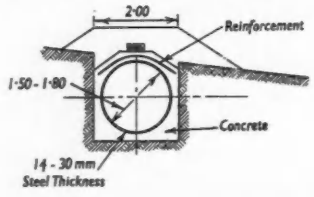


Fig. 24—Cross section of pipeline to Tinzen power station

The intake to the power station of the scheme is nearly half a kilometre away from the dam on the left bank. At the dam the diversion tunnel carrying the flow of the Julia during construction will form the scour culvert of the completed reservoir, and there will be a spillway built on the right bank close to the abutment of the dam. This spillway is to consist of three intakes (see Fig. 20), leading into a single vertical shaft. The first of them is a double siphon intake at the top water level of 1680 (each siphon will discharge 25 cumecs). The second is a horizontal tunnel with an invert level of 1672 and a discharge capacity of 20 cumecs, closed up to the level 1680 by an automatic sluice gate. The third intake consists of two intakes with an invert level of 1666, each closed by a sluice gate 3m by 3·8m in size and each able to discharge 65 cumecs. The two lower intakes may be used to draw down the reservoir rapidly in case of emergency, and were required by the military authorities. Both the spillway and the scour tunnels will discharge into the rocky bed of the Julia just downstream from the dam. When all the works are complete the various water controls will be operated from the power station, but there will be an attendant at the dam, whose duties will include observation of the pore water pressures at a number of points in the dam, from an instrument room beside the tunnel under the dam.

The power station of the scheme is at Tinzen, some 10km below the dam site. It is a surface structure containing two similar horizontal Pelton wheel, turbo-alternator sets, each with two turbines. The total installed capacity is 46MW, the gross head 489m, and the rated flow 12·5 cumecs. The estimated annual production of power is 156 million kWh, of which 85,000,000kWh will be generated during the winter (i.e. between October 1st and March 31st).

The diversion tunnel from the dam is 2·55m in diameter and is 9·4km in length. Between the surge shaft and the power station the rock was not of good enough quality to allow the construction of a pressure shaft. Nevertheless, a conventional pipeline has not been used. A steel pipe embedded in concrete, as shown in Fig. 24, has been built. This design allows of some economy over a pipeline, we were told, in that expansion joints, which were considered essential for a pipeline, have been eliminated.

Below the Tinzen power station there are two existing power stations on the Julia, which at present are operated with only small water storage (200,000 and 260,000 cubic metres respectively). There is also a power station on a right bank tributary, the total installed capacity of the three being 105MW.

With the Marmorera scheme in operation the Julia River will thus yield about 557 million kWh annually, with a winter production of 263 million kWh. Apart from the output of Tinzen power station, the winter power output of the two older stations on the main stream has been increased by 60,000,000kWh, due to the control given by Marmorera reservoir. There remains a small head to be developed between Tinzen and the intake to Tiefenkastel power station, the next one downstream.

(To be continued)

French Locomotive Experiences

By EDWARD H. LIVESAY

(Continued from page 707, May 14th)

No. IX—LOCOMOTIVES Nos. 242.A1 AND 160.A, AND THE VITRY TESTING STATION

TWO of the more interesting locomotives seen in France were stabled at Le Mans and Vitry respectively, and though unfortunately neither was running during my visit, it was suggested that I might like to see them ; when I promptly admitted that I should, arrangements were made for me to do so, this being typical of the thoughtfulness and consideration which I met with throughout my tour. Further, I was promised that when these two fascinating machines came out of temporary retirement, opportunities would be given me to see them in action, which I shall certainly take advantage of—perhaps soon after this article is published.

The first was No. 242.A1, a three-cylinder compound, Smith system, of the 4–8–4 wheel formation, illustrated by Figs. 46 and 47, which I imagine to be the largest and one of the most powerful express locomotives on the S.N.C.F. The other was No. 160.A, a 2–12–0, six-cylinder compound freight engine, with two h.p. and four l.p. cylinders, illustrated by Figs. 48 and 49. Both are unique machines, though not entirely new productions, being expanded rebuilt versions of older types, a practice with which Monsieur Chapelon's name is closely associated, to the benefit of the S.N.C.F. in particular and the locomotive world in general. Unfortunately, just as is the case with other intriguing locomotives which I have dealt with in these articles, such as " U1 " and " P33," these two engines will, I fear, remain first and last examples of their type ; they will have no successors, the ultimate complete electrification of the French railways being the goal now set. However, I do hope to see them in operation in the not very distant future, before their fires are lit for the last time, and then I shall have more to say about them. I hope No. 242.A1 will be hauling a 750-ton train at high speed, and No. 160.A a 4000-ton coal train, when I am in their cabs—" a consummation devoutly to be wished ! "

The run to Le Mans was made in an exceedingly comfortable compartment of a first-class, side-corridor, eight-wheeled coach, the last vehicle of the 9.05 a.m. electric train from the Gare du Montparnasse, where I was taken charge of by a courteous official whom I had already met at Monsieur Segaud's office in the Rue Diderot. His English being about on a par with my French, he was perfectly justified in going to sleep, the schedule being non-stop, and his charge consequently not likely to wander off and get into trouble *en route*. I might have imitated my cicerone, but it was a glorious day, and I wanted to enjoy watching this pleasant land of France swing by from the

comfort of my compartment, and to relax, but not retire, at the beginning of what might prove a long and strenuous day. The level plain, as it appeared, streamed by ; great fields of golden wheat and stubble, broken here and there by low, rolling hills and dark green woods, bisected by straight, poplar-lined roads along which occasional cars and trucks were spinning—certainly there was

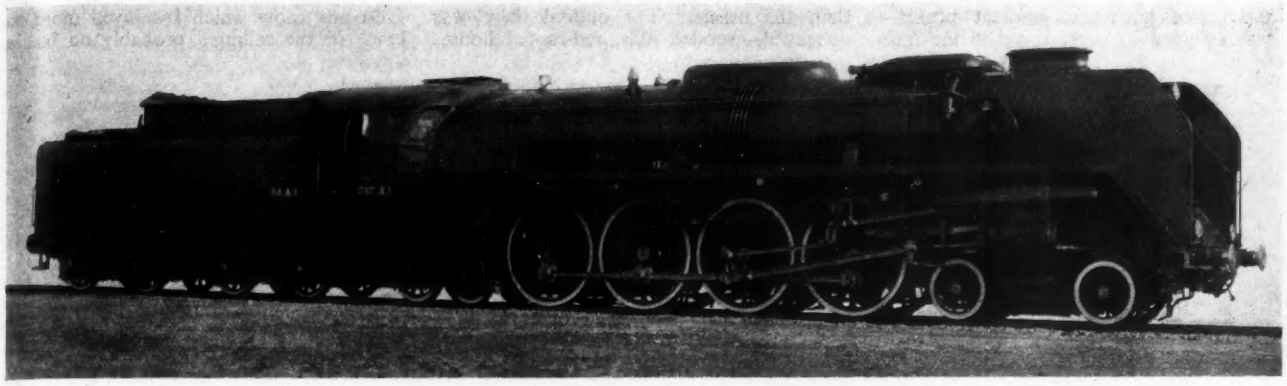


Fig. 46—4-8-4 three-cylinder compound express locomotive, No. 242.A1

less traffic than in England. Pylons carrying cables of a grid system were prominent ; the effect of the long-continued drought was evident here, too, a drought broken on only two days during the whole month I was in France.

The coach was roomier than corresponding accommodation in Britain, both as to compartments and corridor, thanks to the more generous loading gauge of France, and the train was evidently fast, its speed seldom falling below 60 m.p.h., and generally being between that and 75 m.p.h. The motive power being electricity, gradients were imperceptible, though in any case I doubt if they amounted to much over this central plain of France. The coach, the last in the train, ran very well, and was clean, cool and quiet, gently swaying to the rhythmic clack of the joints, the regularity only broken by an occasional chatter over points and switches ; I realised this was one of the fastest runs I have made on rails. It was sleep-inducing, too, and I take credit for not succumbing ; but this was only the beginning of the day, and I was an observer ; returning to Paris in the evening, and riding in the cab—ah, that would be a sterner test ! After a pleasant journey completely lacking in incident, the train came to a stand just outside the station at Le Mans, the platform being occupied, at 11.10 a.m. We remained stationary for 6 min, the final stop being at 11.16 a.m. I have no doubt 11.10 a.m. spelt O.T., or a trifle early, as there did not appear to have been a single check *en route* ; 127 miles had been covered non-stop in 125 min to the signal stop, 61 m.p.h., during which 75 m.p.h. had not been exceeded.

From the station we proceeded to the shed, in the dim quiet of which No. 242.A1 was standing, dead and cold. The superintendent asked if I would like it to be drawn out into the open for photography and my convenience, but I negatived this kindly suggestion, one so typical of the consideration shown me upon so many occasions, as I did not wish to put anyone to the trouble involved. I spent an interesting hour climbing round, under and inside—only the cab—this impressive machine which I gathered had been largely built during the occupation. The enemy would not permit the allocation of the right metal for the high-pressure cylinder casting, so cast iron was used, which was not satisfactory and was subsequently—or is to be—replaced. Then the engine will take to the metals again. We then adjourned for lunch, which was delightful, as all these " turn-around-point " lunches invariably were, the conversation covering a wide field, naturally including my very high opinion of the locomotives on which I had ridden in France. All, I said, with one exception, had been in fine shape and a pleasure to travel on—an American 2–8–2, I explained, on which I had ridden from Dijon to Bourg.

" Ah, an American locomotive ! "—with deprecatory shrugs and smiles, they admitted that might possibly not be quite so well-mannered, so refined, as a Chapelon " Pacific," for instance. What had seemed to be the matter with it ? It was impossible for me to answer that question in the time at our disposal—life is short and we might all have passed away before I had finished. I was sorely tempted to tell my good friends, using forthright Western Canadian phraseology, what should be done with that engine, but on second thoughts that, too, was impossible—we were at lunch and, besides, I was too much of a gentleman.

Returning to No. 242.A1 (Figs. 46 and 47), this engine is based on a 4–8–2 of an older class, redesigned throughout, and with the single-axle trailing truck replaced by one of two-axle " Delta " pattern, necessary because of the larger firebox. From the outline drawing it will be seen that the h.p. valve is driven from the third coupled axle, by an outside crank connected to a swinging lever, and from this by inside gear, the arrangement being easily followed from the diagram. The two sets of valve gear, h.p. and l.p., are not independent, the respective valve travel remaining at a constant ratio, varied by one wheel. High pressure steam can, of course, be admitted to the l.p. cylinders at starting, the pressure being limited to 206 lb. The tractive effort is 46,992 lb and the factor of adhesion 3·93.

There are so many interesting aspects of this engine that an entire article might well be given to them ; I hope to say more about it after having been present as an observer of its performance on the road. Details are on record of many test runs made with loads up to 750 tons, which were handled with ease at high speed and economically. It has the complete equipment that is the rule on French locomotives, going far beyond anything approached in Britain ; the average English driver would be quite at sea in No. 242.A1's cab without a book of instructions ! I confess a good deal of " looking round " will be necessary before I shall feel at home upon it myself if and when I am fortunate enough to travel on the footplate.

Leading Particulars of 4–8–4 Three-Cylinder Compound Express Locomotive

Cylinders :	
High pressure, diameter	24in
High pressure, stroke	28·8in
Low pressure (two), diameter	27·2in
Low pressure, stroke	30·4in
Valves, Piston, Walschaerts gear :	
High pressure, diameter	8in
High pressure, travel	7·6in
Low pressure, diameter	15·2in
Low pressure, travel	6in
Valves, Cut-off :	
High pressure	11 per cent min.
High pressure	80 per cent max.
Low pressure	10·5 per cent min.
Low pressure	82·5 per cent max.
Valves, Maximum opening :	
High pressure, inlet	2·45in
High pressure, exhaust	2in
Low pressure, inlet	4·2in
Low pressure, exhaust	3·2in
Wheels :	
Bogie, diameter	3ft 3in
Driving, diameter	6ft 6in
Trailing truck, diameter	3ft 3in and 3ft 6in
Boiler :	
Minimum, diameter	6ft
Length	21ft 3in
Pressure	294 lb
Grate area	54·5 square feet
Heating surface :	
Small tubes (127)	1427 square feet
Large tubes (33)	987 square feet
Firebox (two siphons)	309 square feet
Total	2723 square feet
Superheater (Houlet)	1310 square feet
Total	4033 square feet
Weights, as per diagram, total engine	148 tons
Speed limit	87 m.p.h.
Nicholson siphons	2
Stoker	" HT 1 "
" Kylchap " triple blast pipe	
Indicated horse-power	5000
Drawbar horse-power	4200

Fig. 47—Outline and loading diagram of three-cylinder compound express locomotive

cab of an electric locomotive handling the train, leaving Le Mans at 3.53 p.m., after coming from Brest via Rennes—or from Nantes via Angers, I will not be positive which, Le Mans being the junction point of these two routes. The distance to Paris is 127 miles and the route is electrified on the same 1500V overhead system described in Article VII. Acceleration was, of course, rapid, as it is likely to be with electric traction, the speed quickly reaching 70 m.p.h. Not having a gradient profile—it was assumed I should travel in the train too close for me! Versailles-Chantier brought the first stop, at 5.57 p.m.; this is a stretch where both steam and electric traction are found, the line from Argentan coming in on the left, dealt with in Article IV. We were nearing Paris from the west, of course, and I could not help being struck by the contrast between entering Paris and London suburbs, respectively, the latter by any route one can name, though the approach to Paddington is perhaps a little less sordid than the others. The outlook here was delightful—wooded hills, red-roofed houses this piece of composition off the rails; what I meant to say was, can anyone imagine finding such a dining room at a London terminus—Fenchurch Street, say, or London Bridge, even King's Cross. No, it is unthinkable; but this was Paris, where the citizens have different ideals; and this was the S.N.C.F., which puts beauty and cleanliness before godliness, if I may be forgiven for saying so—and forgiven by B.R. for hinting they pay little attention to any of them. I do not know which I enjoyed more, the lunch or the ceiling; probably on balance

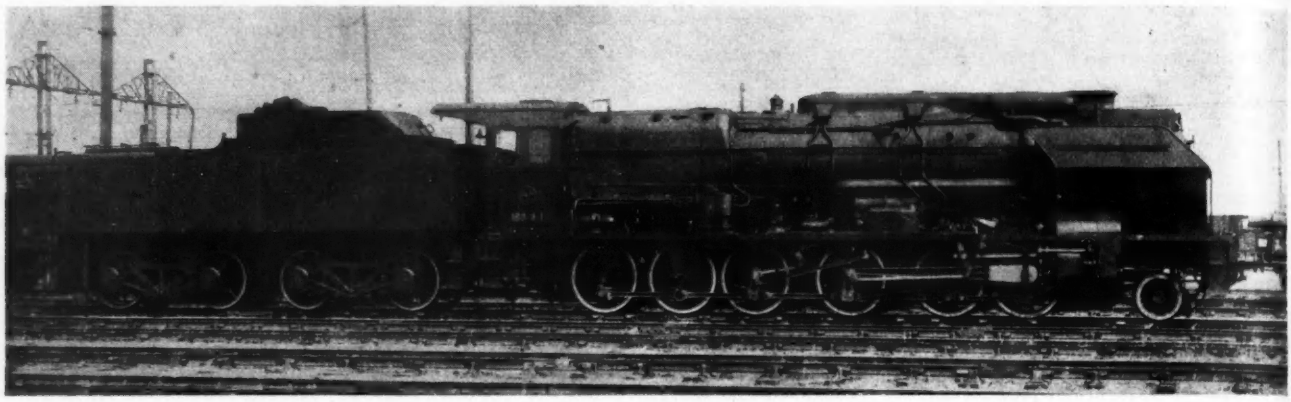


Fig. 48—2-12-0 six-cylinder compound freight locomotive, No. 160.A1

and so should not require one—it is not much good giving many station names or passing times, as they would tell the reader little of value. The first notes refer to the excellent layout of the track, which was generally straight and level and seemed to have been plotted on the principle adopted by the Czar of Russia when he was asked to decide on the route of the line from Moscow to St. Petersburg—he ruled a straight line between the two cities—"Build it thus!" This Le Mans/Paris line seemed to disregard many towns altogether; they could be seen, but we did not go through them. Where there was any curvature it was easy and no speed reduction was necessary, the entries being invariably between 100km.p.h. and 120km.p.h., at which the great machine kept up its drowsy, humming flight. La Fere Bernard passed at 4.23 p.m., doing 110km.p.h.; Pontgoain (probably spelt wrong!), 4.55 p.m. at 115km.p.h., and I was getting very sleepy—fearfully sleepy is the next entry—"shall ask the fireman to let me have his seat and open the window, or shall not be able to stay on my feet, nor keep my eyes open." The combined effects of the hot day, smooth riding, hum of gears, and the lunch were becoming too much for me. But what did it matter if I fell asleep? There is so little to note in an electric locomotive's cab—only readings of speed, amperes and volts, and the latter scarcely varied. Looking back at the train as it rounded a curve, it was evidently long and heavy, fifteen/sixteen coaches, 650/700 tons, but what did that matter either? It is the generating station that is doing the work, the engine being merely a portable converter. It is a soulless thing, a robot; I cannot wax enthusiastic over an electric locomotive. My notes soon become really poignant: "Aching for sleep—if only I were home in Paris!" I seem to have overlooked Chartres altogether, the most important town *en route*; but Coignieres was entered, 5.43 p.m., still doing 110km.p.h; four tracks and an engine-shed made it appear as though Paris were not far away; it could not be among the trees, the Eiffel Tower in the distance—clean, bright, attractive, utterly different to all approaches to "The Smoke." And, over all, blue sky and the sun shining through air crystal clear—don't they burn any coal in Paris? If they do why is it there is never any soot, smoke, stink? There were none here. Now, as I was thoroughly awake, the train ran into the Gare Montparnasse, coming to a stand at 6.10 p.m.; 127 miles in 137 min, with one stop at Versailles, 55·7 m.p.h. Nothing spectacular and not nearly so fast as the Dijon/Paris run, but a pleasant finish to a very interesting day. Thence, by way of the Metro, to the Gare St. Lazare, and from there by electric local train to Asnieres, where I was awakened and put off by a train-hand who, thanks to *le bon Dieu*, knew me and my habits, and that I needed looking after. But for him I should probably have shuttled to and fro into the small hours, dead to the world, and have ended up in the carriage-cleaning yard.

Next day's programme included the Vitry Testing Station, beginning with lunch in the very fine restaurant at the Gare du Lyon, with Messieurs Bohl and Segaud. Another glaring contrast—can anyone possibly imagine himself enjoying in a London station a perfect meal in a charming room, embellished overhead by a positively glorious ceiling, the work of a great painter, whose name I forget, but he is dead anyway—one of the artistic prides of Paris? I see that my enthusiasm has sent there was a slight trend in favour of the former, but both were outstanding. I was then driven to Vitry, accompanied by Monsieur Bohl, who had been directly concerned in the planning and construction of this famous testing plant, which was put into operation in 1933. To my knowledge, the first locomotive testing plant was built in the States over sixty years ago, other installations coming about subsequently at Swindon and elsewhere, none of them, however, equalling the Vitry establishment in scientific completeness and efficiency. The Rugby plant, of course, was based on Vitry, and is probably even more advanced. A brief outline of its chief features is apropos, and the *raison d'être* for a testing plant, which supplements the data obtained from a dynamometer car. Though the latter is of great value, running conditions—speed variations, stops, weather, and so on—are apt to interfere with recordings, and add to the difficulty of obtaining accurate information; a stationary testing plant, on the other hand, gets round these drawbacks, and tests can be continued as long as is necessary until the desired data are complete. No doubt the Vitry station has had much to do with the advanced design and fine performance of French locomotives, which in many respects have set the fashion to the locomotive world. The Rugby plant will probably be equally efficacious where British engines are concerned; many of the faults of pre-war British locomotives might have been eliminated had a proper testing

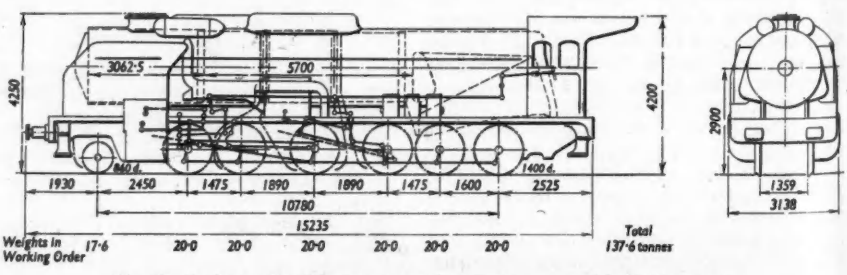


Fig. 49—Outline and loading diagram of six-cylinder compound freight locomotive

plant been available sooner.

The main building housing the test bed is 180ft by 80ft and contains the whole equipment necessary—the jack-supported girders carrying the rails beside the pit, flanked by the Froude brakes, which absorb the power developed by the engine under test, of which there are six, three on each side, staggered, enabling a twelve-coupled engine to be tested. Each brake can absorb 1200 h.p., and rotation corresponding to a locomotive speed of 100 m.p.h. is allowed for, with an axle load of 30 tons, well over what is ever likely to be necessary. All the dials, recording tables, &c., are concentrated on a control platform at the end of the test bed, and from it all the required changes in braking resistance to absorb the engine's power can be regulated. The pull of the engine is taken by a drawbar

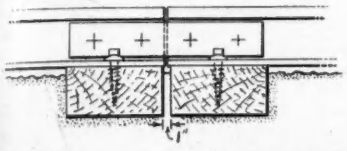


Fig. 50—Arrangement of double-sleeper rail joint

to a hydraulic dynamometer in a separate room beyond the control bridge. In this room recordings are made of steam pressure in the boiler, cylinders, intermediate receivers of compound engines, and of the exhaust; the draught in the firebox, in the smokebox; temperature of the steam at different points in the boiler, in superheater and steam chest; gas temperature in firebox and smokebox; temperature of feed water also at various points, and the chemical make-up of combustion gases. Every possible recording is made, many of which would be out of the question with only a dynamometer car as the instrument, and it would be difficult to overestimate the value of such a testing plant as Vitry or Rugby. No locomotives happened to be under test on the occasion of my visit, but the unique 2–12–0 six-cylinder freight engine No. 160.A (Figs. 48 and 49) was in the adjoining engine shed, and I was enabled to look round it before leaving the station. Some of its chief details and dimensions follow.

Leading Particulars of 2–12–0 Six-Cylinder Freight Locomotive No. 160.A

Steam pressure			271 lb
Cylinders:			
High pressure (two)			20·8in by 21·6in
Low pressure (two), inside			20·8in by 21·6in
Low pressure (two), outside			25·6in by 26in
	H.P. cyls. (inside)	L.P. cyls. (inside)	L.P. cyls. (outside)
Diameter of inlet valves	8¼in	8¼in	10⅛in
Diameter of exhaust valves	8¼in	8¼in	10⅛in
Lift of inlet valves	1¼in	1¼in	1¼in
Lift of exhaust valves	1¼in	1¼in	1¼in
Cut-off, minimum	10·5%	11%	11%
Cut-off, maximum	78%	80%	80%
Maximum receiver pressure	147 lb		
Boiler:			
Diameter			5ft 10in
Length			19ft
Heating surface:			
Firebox (Nicholson siphon)			252 square feet
Large tubes (107)			1996 square feet
Small tubes (14)			125 square feet
Total evaporative			2373 square feet
Superheater, high pressure (Houlet)			786 (39 elements)
Superheater, low pressure (Schmidt)			1206 (68 elements)
Total			1992 square feet
Total evaporator and superheater			4365 square feet
Grate area			48 square feet
Wheels, diameter, truck			3ft 2½in
Wheels, diameter, driving			4ft 8in
Weights			As per diagram
Tractive effort (at b.p.)			65,230 lb, working compound
Factor of adhesion			4·05
Speed			Limited to 55 m.p.h.

As will be seen from Fig. 49, the high-pressure cylinders are placed well back, between the second and third coupled axles, driving the fourth, the valves being driven by outside return cranks. All four low-pressure cylinders are in line, two inside and two outside; the former two drive the second coupled axle, the latter pair the third. The low-pressure valve gear (Walschaerts in all cases) is operated from the third axle by outside gear, suitably conjugated, the valves being of the oscillating cam poppet Dabeg design. As is always the case with modern French engines, the two sets of gear, high-pressure and low-pressure, cannot be separately controlled, one reverse wheel simultaneously varying the travel of both, the ratios being fixed. The steam is, of course, superheated before reaching the high-pressure cylinders, and after leaving them it passes through another set of Schmidt elements *en route* to the low-pressure cylinders. Other details include a "Kylchap" double blast pipe with variable nozzles, steam jacketed cylinders, electric light, and Westinghouse operated brakes.

This engine is capable of handling trains of 4000 tons weight, but in this connection one wonders whether screw couplings would be effective when such loads are involved and whether existing sidings are big enough to contain the trains. However, the S.N.C.F. has probably taken these factors into consideration and has solutions to the problems—but I was not informed what they were!

* * *

During my stay in France I visited the La Chappelle Locomotive Depot, in the northern Paris suburbs, where I believe express engines only are shedded. I spent a very interesting afternoon there under the guidance of Monsieur Hanroy, one of Monsieur Chapelon's staff, whose excellent English made the excursion all the more enjoyable. "My beloved U1" was stabled there, and that day happened to be undergoing a routine check-up, which enabled me to get upon even more intimate terms with this fascinating machine when it was in a state of rest. I was again told that if further express locomotives should ever be built for the S.N.C.F.—which is very unlikely—they would be three-cylinder Smith system compounds—four-cylinder designs are definitely "out." This is not because they are unsatisfactory or inefficient, but because they are needlessly expensive to build and maintain—after all, if three cylinders can do the work, why use four? I remember asking the same question in THE ENGINEER before the war, when dealing with the fine Stanier "Princess Coronations," which—apart from "U1" naturally!—are at the top of the list of my locomotive idols. The point is, of course, that both designs were evolved before the war, when cost was not so vital as it is now.

The matter of the very fine running condition of French locomotives, which had so impressed me both from the cab and lineside, came up, and I inquired about it, suggesting that the best of help must be available in the shops to ensure it. It was admitted that the shops were well staffed as to the higher, skilled ranks, and ratings, but that there was a scarcity of help among the lower grades. A forty-four-hour week is worked, which is "staggered," forty and forty-eight alternately; that is, an 8½-hour day and a 5½-day week. The equipment of the La Chappelle shops, which were clean, well arranged and lighted, was very complete, and included a water softening plant. Before this was adopted boilers had to be retubed and restayed every 200,000 miles, but now this is only necessary every 600,000. Work done on the engines averages one hour for every 620 miles run.

It was again stated at La Chappelle that French enginemen begin as firemen and work their way up from the shovel, just as is the case in Britain, and as far as I know in all other countries; this was the rule, but, like most rules, there were exceptions—I came across one or two of them. They very seldom begin as mechanics and come direct from shops to footplate. The matter of briquettes was also touched upon, and I was told they are only provided for use in shed or station, and that only a poor fireman would employ them out on the road unless for exceptional reasons. I never saw them used on an express train, and in one case they were not provided.

When as a child I first became interested in railways, I noticed the way rail joints "dipped" as the wheels passed over them, and the "clack," telling of shock and wear, and pondered ways and means of preventing it. One idea was by staggering the joint—I believe this has been tried and discarded—but my favourite scheme was the provision of a sleeper directly under the joint, and I wondered why this was not done; in fact, I have wondered ever since! Even if a chair could not be fitted on account of the fish-plate, a sleeper might be *in situ*. In France I noticed how the "dipping" problem had been tackled; Fig. 50 is self-explanatory; it struck me as a very practical solution. After returning to England, the matter being still in mind, I saw the same, or nearly the same, arrangement where flat-bottomed rails had been laid, so I presume it will become standard in Britain too, now that the bull-headed rail is being replaced.

(To be continued)

"Aqualungs" for Underwater Exploration

THE sport of underwater swimming, fishing and exploration has expanded rapidly and the "Aqualung" equipment made popular by Captain Cousteau, the French underwater explorer, is now manufactured under licence by Siebe, Gorman and Co., Ltd. At the invitation of the company we were able to witness recently a demonstration, by the company's divers, of the "Aqualung," which is manufactured in three sizes. These are the "Standard Essjee" unit, with one compressed air cylinder; the "Twin Essjee" "Aqualung," with two cylinders, and the "Junior Tadpole" unit, with one small cylinder.

The equipment consists of one or two cylinders, made of light steel alloy, each capable of holding 40 cubic feet of free air when charged to 1800 lb per square inch, and strapped to the back of the swimmer by a webbing harness, which includes a belt carrying a number of 1 lb lead weights and fitted with a quick-release clip. A two-stage demand valve on the cylinder regulates the flow of air to the lungs, the air passing by means of twin corrugated rubber breathing tubes to a moulded rubber mouthpiece and there is also a pressure gauge connected to the cylinder by a flexible pressure tube, which measures the amount of air in the cylinder in atmospheres. The equipment includes a dive mask of moulded rubber with a detachable metal framed window and a rubber nose clip. The weight in air of each of the three styles of equipment is 25 lb, 50 lb and 20 lb respectively, but the "Aqualung" weighs practically nothing when under water. The time which a swimmer can stay under water when wearing an "Aqualung" varies according to operational depth and the amount of effort put forth, and the following are the operating depths and related times assuming light exertion. At depths of 12ft, 33ft, 60ft and 100ft, the standard model allows the swimmer to continue under water for thirty-five minutes, twenty-two minutes, fifteen minutes and ten minutes respectively, the corresponding times for the twin unit being exactly double, while the "Tadpole" equipment allows for operating times of twenty-four minutes and twelve minutes at depths of 12ft and 33ft respectively.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Institution of Heating and Ventilating Engineers, which has occupied a number of temporary offices since its premises were damaged during the war, has now acquired new premises at 49, Cadogan Square, London, S.W.1. The Institution moved into its new headquarters, which are of a size adequate to allow for any future expansion of staff, on November 9th of last year.

Gauge and Tool Exhibition

THE fourth Gauge and Tool Exhibition was opened by the Minister of Supply, Mr. Duncan Sandys, at the New Horticultural Hall in London on Monday last, May 17th, and will be open daily until Friday, May 28th. At this exhibition, which is organised by the Gauge and Tool Makers' Association, about ninety of the leading gauge and tool-making companies in this country are showing their latest products. The exhibits show the high standard of craftsmanship and design maintained by this very important branch of British industry, which has developed so considerably during the past fifteen years or so. In addition to an impressive number of exhibits of standard designs of gauges, measuring equipment, small tools, &c., particular interest attaches to the many jigs, fixtures, moulds, tools and pieces of equipment made to special requirements which are being shown by a number of firms.

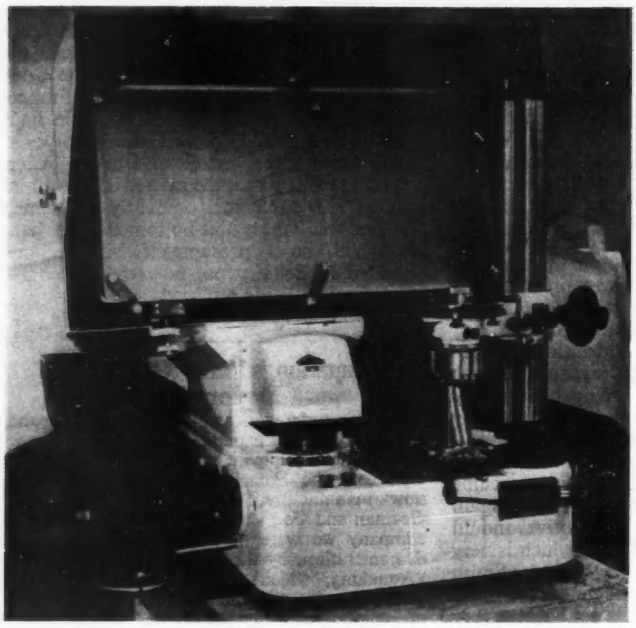


Fig. 1—Projection "Pantometer" in use checking the profile of a turbine blade

For our descriptive review we have selected some of the tools and equipment of new and special design being exhibited, and these descriptions indicate in some measure the way in which gauge and toolmakers provide for the whole field of manufacturing industry in this country.

The products of two firms are shown on the stand occupied by Newall Group Sales, Ltd., of Peterborough—Optical Measuring Tools, Ltd., and Tolimit Gauges, Ltd. The equipment of Optical Measuring Tools, Ltd., includes examples of its well-known "Omtimeters," toolmakers' microscopes, and precision tables, and the projection "Pantometer" illustrated in Fig. 1. This "Pantometer" is designed for experimental and development work involving the inspection of three-dimensional contours, such as with turbine blades necessitating frequent changes in blade profile, and where the master against which the work is to be compared must be capable of quick and simple preparation. The master profile is traced ten times full size on translucent material or tracing cloth and clipped to a glass screen as shown in the illustration.

The workpiece to be inspected is mounted vertically in a holder which is easily adjustable for rotational movement and for height adjustment to the points at which it is required to inspect the blade. For laboratory purposes a precision circular scale is fitted to the holder and means of slip gauge height location are provided. The instrument has two diametrically opposed styli mounted on a freely floating table and these styli are lightly spring loaded with automatic reversal of direction against the blade sides. The action of following the blade contour is effected by rotation of a handwheel which traverses one stylus along one side of the blade. When the end of the blade is reached the other stylus is automatically brought into action and as the handwheel is turned back again it traverses the opposite side of the blade. The floating table which is connected to the styli also carries two projection lenses spaced at an identical distance apart to the two styli, and as the stylus follows the blade contour the lenses follow a similar path.

The stylus point is represented on the screen by the projected image of a graticule mounted on the same common base. As the handwheel is traversed the projected image of the stylus moves around the contour of the form on the master drawing, and any discrepancy between the actual blade shape and the drawing is apparent on the screen.

The instrument gives a magnification of ten times on a screen 24in by 12in, and the maximum height between stylus and face of workholder bracket is 16½in.

Amongst the range of tools, jigs, fixtures and press tool sets shown by the Plessey Company, Ltd., of Ilford, Essex, is a recently introduced design of pillar bolster set. Each of these new die sets consists of a backing plate, punch plate, stripper and die with all the plates pre-machined and accurately ground and pre-assembled to eliminate need for preparatory work in the users' toolroom. These prefabricated bolster sets are available in three sizes to accommodate nine sizes of die from 3in by 3in to 5in by 6in, and with them trigger stops, hinge pins, springs and starting stops can be supplied in various sizes. If required, other indexing equipment such as pin stops, side cutter or roll feed can be used with the sets.

The standard drill jigs shown by the firm include leaf drill jigs, sandwich drill jigs and box drill jigs for three-face drilling. To speed production these jigs can be supplied with an adjustable hinge pin which allows any thickness of material to be accommodated without structural alteration or packing and a quick-release wing nut clamp and threaded latch is provided on all standard drill jigs. This form of clamping allows the jig leaf to be released by a half-turn of the wing nut, the jig body being chamfered to permit the latch to swing clear for easy component removal.

The new equipment to be seen amongst the range of "Matrix" gauges and measuring instruments made by the Coventry Gauge and Tool Company, Ltd., Fletchamstead, Coventry, includes a new 8in high-precision, tilting and rotary table for use on small jig boring machines or for inspection purposes. This table has an overall height of only 7in in the horizontal position and 10½in in the vertical position, and the angle of inclination is read by means of a built-in vernier to one minute of arc.

One of the firm's "Tri-Roll" thread gauges is illustrated in Fig. 2. These gauges are specially designed and built for quick and accurate inspection of pitch, angle and effective diameter of mass-produced threaded components with the dimensional control within a stated tolerance. They are available in six models which enables a range of either left or right-hand threads from 0·1in to 1·5in diameter to be checked. Supplied with each size of gauge is a comprehensive range of rollers, which can be quickly changed and together cover a very wide field of thread forms.

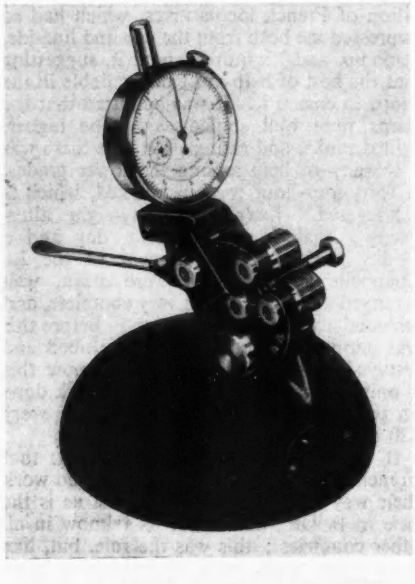


Fig. 2—"Tri-Roll" screw thread comparator

The full-length rolls provide a functional check on the threads, and errors in pitch, angle and effective diameters are read cumulatively on the indicator dial. Where a check on effective diameter alone is required, rolls having two ribs only are available. These rolls are truncated to ⅛ pitch, flat on their major diameter and cleared on the minor diameter. Errors in angle pitch or interference at the minor diameter can easily be seen by visual inspection whilst the work is in the gauge.

An optical twist drill gauge for drills from $\frac{1}{32}$in to ¼in diameter now made by the firm is illustrated in Fig. 3. This gauge consists of a cast iron base carrying a projector assembly which includes a lamp housing, lens and translucent screen. Between the light source and the screen is a vee block for carrying the various sizes of drills, which, when in position, cast a sharp shadow outline of the drill tip upon the screen at a magnification of five times.

Two lines engraved on the screen are set accurately to the angle of the drill point. In operation, the drill is inserted and by adjusting the focusing control a silhouette of the drill point is cast sharply on the screen. By means of a movable stop the image is positioned so as to be coincident with the graticule on the screen and any variation in angle can be detected.

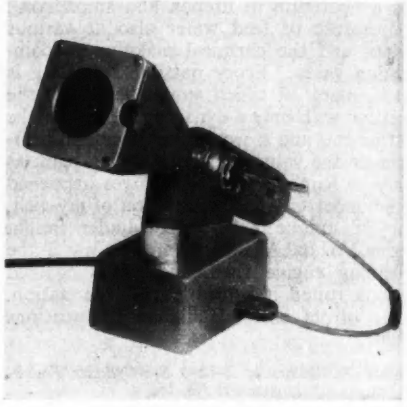


Fig. 3—Optical twist drill gauge

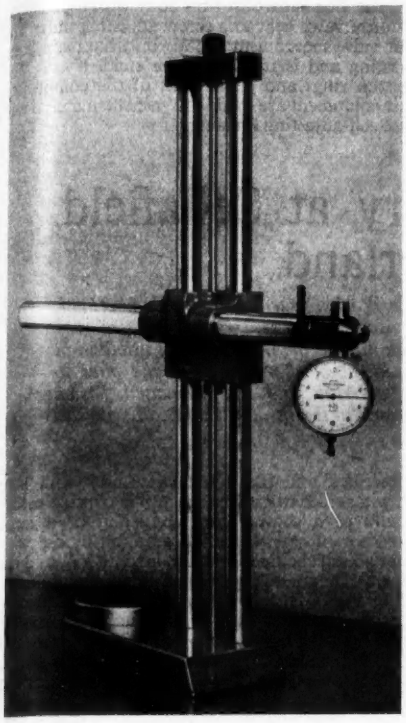


Fig. 4—Precision indicator stand

In addition to its cutting tools and ancillary equipment a new compound table made in two sizes with working surfaces 7in square and 12in by 6in, is shown by A. A. Jones and Shipman, Ltd., of Leicester. The smaller of these tables is stated to be particularly adaptable for electrode machining as the spigoted table top can be removed for the fitting of an immersion tank to the top slide. This table can also be supplied with reduction gears to the longitudinal and cross traverse screws and fitted with adjustable graduated rings calibrated in 0·0005in divisions.

The standard tables are supplied with adjustable graduated rings having dials calibrated in 0·001in divisions. Both the longitudinal and cross slide faces are machined for accommodating slip gauges. The maximum error on the table top on all overall movements is stated to be 0·002in.

Impregnated Diamond Products, Ltd., of Gloucester, is demonstrating its "Sparctron" technique of machining metals by spark discharge. This process makes it possible to carry out in hard, tough metals most machining operations, although at present the principal industrial applications are confined to operations for the production of holes and forms where the component can be held stationary.

Fig. 5—Milling machine fitted with hydraulic tracer control unit

The new equipment made by J. Goulder and Sons, Ltd., of Kirkheaton, Huddersfield, includes a universal beam caliper for measuring large external and internal diameters, and the precision indicator stand shown in Fig. 4. This precision stand is made in three sizes, the largest of which has a reach of 20in and is 40in high. It can be used for transferring dimensions, squareness measurement or as a comparator stand.

The stand consists essentially of a heavy base of case-hardened nickel steel which carries two precision ground tubular uprights with a sliding saddle bored to take a tubular cross arm. The sliding saddle moves freely and smoothly on the twin uprights and is firmly locked to them at three points by finger pressure on a single locking lever. A means of sensitive fine adjustment provided enables precise settings to be made even when an indicator is being used at the full reach of the cross arm.

The "Hydrotracer" hydraulic copying equipment made by Hayes Engineers (Leeds), Ltd., Gelderd Road, Leeds, is to be seen in operation on a "Diemaster" milling machine as shown in Fig. 5. This equipment is designed for use with many types of standard machine tools to convert them into accurate profile copying machines. It can be used for duplication of profiles from templates or master workpieces.

The equipment consists of a sensitive tracer connected to a compact hydraulic cylinder unit coupled to a self-contained motor-driven hydraulic pump. The stylus pressures can be adjusted from 8 oz to some pounds. It is stated by the makers that the tracer gives particularly quick reaction to changes in profile owing to the fitting of a composite valve which not only follows and reacts to contour variation, but eliminates static friction through the whole system by means of a pulsatory oscillation superimposed on the hydraulic circuit. This oscillation has a frequency of 1500 impulses a minute and is of micro amplitude, and it has the effect of reducing to a minimum the time lag in the reversal of machine slides. The tracer units are made with universal stylus movement or with vertical movement only or with vertical and swivelling movement in one direction only.

An adjustable plug gauge introduced by T. Bowers and Co., Ltd., Thornbury Street, Bradford, is shown in Fig. 6. This design of gauge is set by inserting standard setting rings on a central pin between three measuring anvils. These anvils can slide in slots in the head of the gauge and once set can be firmly locked in position by tightening socket head screws. A range of setting rings is available, but intermediate dimensions can be set by using standard slips between the central pin and the inside faces of the anvils. This firm is also showing an improved form of its internal micrometer and a selection of the cutting tools it makes.

The new "Superset" electrical comparator now being made by the Sigma Instrument Co., Ltd., of Letchworth, Herts, is claimed to enable comparisons within two millionths of an inch to be made. This instrument, illustrated in Fig. 7, is completely self-contained except for the single-phase electricity supply required, and it can be set up and operated by an unskilled person. It has a maximum throat depth of 3½in and its vertical capacity is 6in, the measuring pressure of 8 oz being constant over the whole range of the instrument.

It is fitted with a 6in long triple scale and through a three-way switch at the front of the base the range and magnification required can be selected. With a magnification of 10,000 to 1, the range is minus 0·0003in to plus 0·0003in, and the scale division represents 0·00001in. With a magnification of 15,000 to 1, the range is minus 0·0002in to plus 0·0002in, and one division of the scale represents 0·00005in, With a magnification of 30,000 to 1, the range is plus 0·0001in to minus 0·0001in, and one scale division represents 0·00002in.

The measuring head is mounted on a vertical column carried by a massive base which houses the electrical apparatus. Variation of size is sensed by the measuring tip and is translated by a transmitter unit through a galvanometer compensated for voltage and frequency drift to a needle traversing the triple scale viewed through an opening in the upper surface of the base. The measuring head is adjusted for height on the column by a knurled threaded ring and is locked by a gripscrew. Release of a second knob permits rotation of the head about the column. A coarse adjustment of the head is effected by a knurled wheel behind the head, and a measuring tip lifter raises the tip about ¼in for clearance purposes. Fine zero adjustments are made electrically by a rotary button on the front wall of the base.

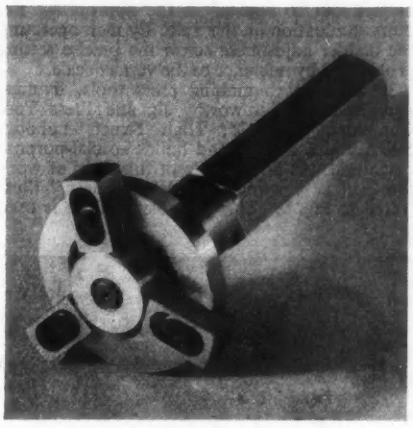


Fig. 6—Adjustable plug gauge

A useful little instrument designed to facilitate the accurate setting of dividers has been developed by the Leytonstone Jig and Tool Company, Ltd., High Road, Leyton, London, E.10. The instrument (Fig. 8) consists of a vernier head attached to a 6in long scale with indentations at ¼in spacings along its length. The vernier head has a movable centre point which operates over a distance of ¼in at the zero end of the 6in scale. When it is required to set a pair of dividers one leg is first placed on the movable centre point with the scale reading zero and the other leg

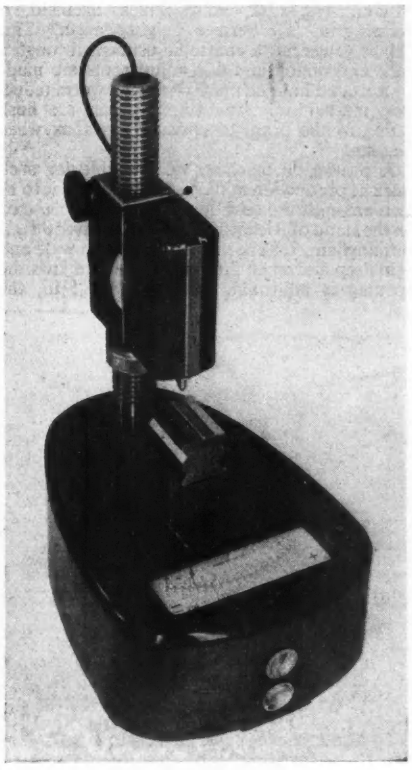


Fig. 7—Multi-range comparator

opened out to register in the appropriate pin point graduation on the rule. By then operating the divider adjustment screw the precise setting is obtained by reference to the vernier scale.

In addition to making press tools, fixtures, jigs, &c., the Kemworthy Jig and Press Tool Company, Ltd., 25, High Street, London, S.W.19, also designs and builds special-purpose machines. As an example of this class of work the firm is showing the "Weld-Prover," illustrated in Fig. 9. This portable machine is used

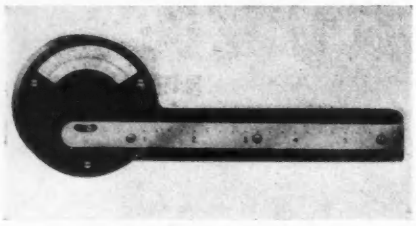


Fig. 8—Precision divider setting instrument

for removing specimens from welded butt joints for purposes of examination. The specimens it cuts are boat shaped and the cut sides have a spherical curvature, the size varying in proportion to the thickness of the plate. By this means a solid portion of the welded joint can be obtained which includes the weld metal, fusion zones and adjacent base metal.

The machine has a special saucer-shaped saw driven through worm reduction gearing by a ¼ h.p. electric motor. This assembly is mounted in its casing on two pivots on the centre line of the curvature of the saw so that when the saw is rotating and the unit is fed downwards it swings on the pivots and the saw cut made is spherical in shape. After one cut has been completed the unit is indexed through 180 deg. and a second similar cut is made to leave the specimen free to be lifted out of the weld. The boat shape of the specimen prevents its falling through the hole when the saw is withdrawn after the second cut. The machine is mounted on the work through a mounting frame supported by four ½in bolts tack welded in position on the job.

With its standard range of internal and external micrometers the firm of Shardlow Micrometers, Ltd., Petre Street, Sheffield, is showing a new vernier height gauge. This height gauge has a coarse adjustment through a rack and pinion and fine adjustments are made by a second knurled knob through a worm reduction mechanism. The vernier scales are flush fitting to the beam to eliminate parallax when reading.

A pneumatic machine vice suitable for such work as production milling of components is to be seen amongst the selection of cutters, tools, &c., on the stand of Richard Lloyd, Ltd., Oliver Street, Birmingham, 7. The vice has jaws 6½in wide and 1½in deep and when fitted with standard jaws the opening is adjustable from 2⅞in to 5½in, the maximum jaw movement in operation being ⅛in. With an air line pressure of 80 lb per square inch the jaws in any position exert a constant pressure of 1¾ tons on the work. The movable back jaw is adjustable through its screw to suit the size of workpieces down to ⅛in thick.

The vice has a cast iron body with a phosphor bronze valve gear and screw adjusting nut. The air valve mechanism is housed in the main body casting and is operated by a small lever. The piston rings and gland seals of the compressed air equipment are made of synthetic material and are self-adjusting for wear.

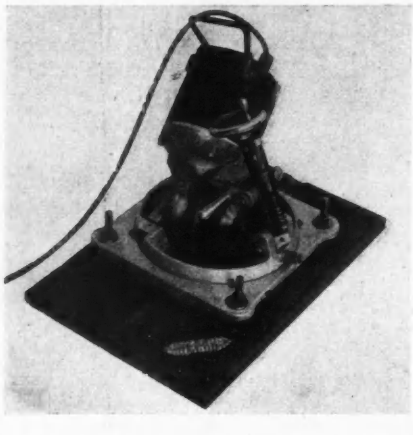


Fig. 9—"Weld Prober" for cutting out specimens from butt welded joints

Plutonium Factory at Sellafield, Cumberland

Plutonium is manufactured at the Windscale Works, near Sellafield, Cumberland, which is operated by the Department of Atomic Energy. Here we refer very briefly to the manufacturing processes, which involve the irradiation of uranium in two piles and the subsequent chemical treatment of the product of the piles to separate the plutonium, the uranium, the solvents and the unwanted fission products. Some reference is made to the work of the medical and health physics services.

ON May 6th, at the invitation of the Department of Atomic Energy, we visited Windscale works at Sellafield, Cumberland, where plutonium is produced by irradiating uranium in two piles and by subsequent chemical separation. The Windscale site was occupied by an explosives factory during the war. Later, the factory was taken by Courtaulds, Ltd., for the production of rayon but, when it was learned that the Government was looking for a site for an atomic energy plant, the company offered to surrender the site. Compared with the alternative site at Drigg, nearby, Sellafield had the advantage of being equipped with railway sidings, office buildings and some service buildings, including a canteen, which saved twelve months of construction time. A supply of water was available from Wastwater, without the need for any engineering works at the lake itself.

Work on the site was started in December, 1947, and the first pile went into operation in December, 1950. At the peak of the construction work Windscale gave employment to nearly 5000 men, in addition to a professional staff of architects, engineers and surveyors numbering more than 300. For the whole of the construction the Ministry of Works acted as agents for the headquarters establishment at Risley.

To-day, the Windscale factory occupies nearly 300 acres and is divided into three main groups. The first group contains the two piles and their associated services. The second is the chemical group: it contains the large chemical plants for separating the plutonium from the irradiated uranium and from the other fission products and the solvent. Associated with these separation plants are well-equipped research and analytical laboratories. Finally, there is the main group which contains all the factory services, boiler-houses, workshops, substations, offices, stores, surgery and fire station.

Some idea of the size of the establishment is conveyed by the fact that it employs 3000 people, including 1860 industrial workers (of whom 450 are classed as skilled); 460 employees are concerned with administration, 500 with analytical and research work, and 100 with canteens; there are fifty-six apprentices.

The Windscale Piles

Plutonium is produced at Windscale by the irradiation of uranium rods in two air-cooled, graphite-moderated piles. These piles have been described and illustrated elsewhere,* and here it will suffice to say that each pile consists essentially of a central core consisting of a large number of square section graphite blocks with horizontal channels in which are laid longitudinal rows of uranium rods sealed in aluminium cans. A graphite reflector surrounds this central core which becomes highly radio-active when the pile is in operation. Protection from the radiation is provided by a roof and walls of concrete several feet thick. To shield the concrete from the heat generated in the pile it is lined with sheet steel. The piles are built on a foundation of alluvial ballast which will carry a load of 2·5 tons per square inch. Each pile rests on a concrete raft with an area of 21,000 square feet, carrying a total load of 58,000 tons.

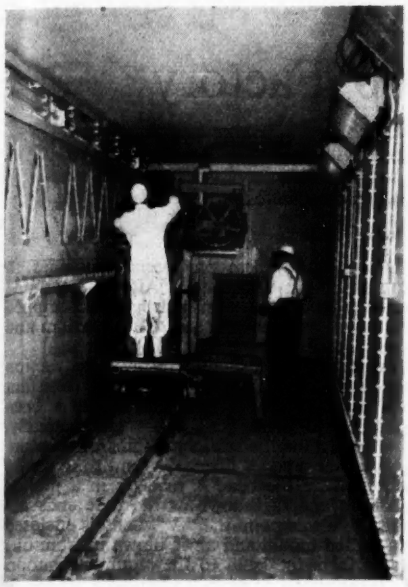
Typical protective clothing for maintenance workers in the Windscale factory. The men can be equipped with walkie-talkie sets

Cooling of each pile is provided by air which is blown through channels from the front to the back of the core and is discharged up a 420ft chimney. The chimney is lined with "Alclad" to protect the concrete and there is a filter chamber near the top of the chimney to remove radio-active particles from the effluent. The cooling air for each pile comes from two blower houses, one on each side of the pile, as illustrated opposite. The walls of the blower houses contain wet and dry filters to clean the inlet air, which is supplied to the pile by double-entry centrifugal blowers, each of which is driven by a 2400/3000 h.p., wound-rotor, 11kV, induction motor running at a normal speed of 990 r.p.m. Dustproof

* Sir Christopher Hinton, "Nuclear Reactors and Power Production," I.Mech.E., and THE ENGINEER, March 5 and 12, 1954.

concrete is used for the floors of the blower houses and the air ducts to the pile are lined with "Alclad" to prevent erosion of the concrete.

Control of each pile is effected by twelve control rods on each side, which can be inserted into the pile to decrease its operational level or withdrawn to increase the level. Movement of the rods is by motor-driven rack and pinion. Two rods on each side are independently driven to give fine control and the remaining rods are driven in groups of five to give coarse control. Emergency shut-down of the pile is effected by a group of vertical rods which fall by gravity through the roof into the core. Operation of the pile is controlled from an operations room where there is a central control desk and an instrument board giving an indication of power level, air speeds and temperatures, blower speeds, radioactivity in the chimney stack, &c. Position indicators are provided for each of the shut-down rods and control rods. Full operational interlocks are incorporated to ensure the correct sequence of starting up and shutting down. For example, the pile cannot be activated until the blowers are running and the control dampers are open. If the cooling air falls below a certain value the pile is shut down.



Part of the railway which serves the filter chambers at the top of the chimney stack

The uranium rods are loaded in cartridges by a charge hoist feeding the charge face of the pile. In front of the charge hoist is a passenger and goods lift and in front of that is a biological shield of concrete. The irradiated cartridges are unloaded from the discharge face at the opposite end of the pile, whence they are pushed out and fall into skips carried on trucks in a water duct. The trucks are transferred on rails under water to storage ponds for cooling.

In the storage ponds, which provide an 18ft depth of water, the skips are unloaded from the trucks and placed on the floor of the pond by a grab carried by an overhead travelling gantry. When the cartridges have cooled sufficiently they are withdrawn under water to sub-ponds, where they can be decanned. Here the cartridges are removed by the light of underwater mercury-vapour lamps with the help of an 18ft handling tool.

All the preceding handling operations in the storage pond are "blind," because of the depth of the water. To carry out these blind operations the position of each skip must be recorded so that the skips can be recovered as required for transfer to the sub-pond. Charting of the position of each skip is done with the help of a photo-electric system installed on the travelling gantry, working in conjunction with a castellated rail. Such a system enables the plan co-ordinates of each skip to be recorded when it is dumped on the pond floor after being unloaded from the truck. By this means the grab can be repositioned to within an inch of any skip.

Separation of Plutonium and Other Products

The product from the piles consists essentially of uranium metal containing a small quantity of plutonium, together with a number of highly active fission products. It is the function of the subsequent processes in the Windscale production plant to separate the plutonium, the uranium and the fission products, and to purify the plutonium and uranium. The separation is done by a solvent extraction process which is carried out in two stages. In the first stage, the uranium and plutonium in solution are together separated from the fission products; in the second stage the plutonium is separated from the uranium.

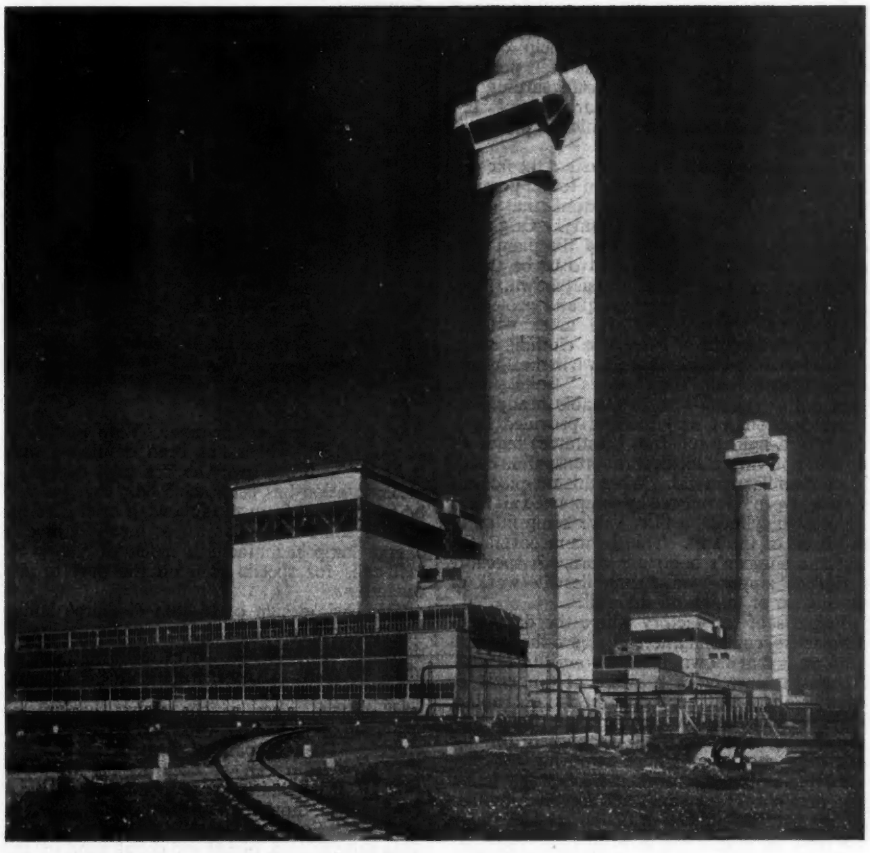
The process is effected continuously in counter-current solvent extraction columns consisting of circular section pipes, each about 20ft long and a few inches in diameter. An aqueous solution of the irradiated slugs in nitric acid is introduced at the top of the extraction columns and a solvent is fed under pressure at the middle of the columns. Mixing of the solution and the solvent is enhanced by turbulence by cylindrical steel rings which are fitted at intervals on the inside of the columns. By correct adjustment of the conditions the uranium and plutonium in the aqueous phase are transferred to the solvent phase, which emerges from a pipe at the top of the column. At the same time, the aqueous phase containing the fission products is drawn off from the bottom of the columns. For the second stage of the separation the solvent phase is transferred to other similar columns, where the plutonium is separated from the uranium.

The primary separation of the products from the pile involves the handling of highly radioactive materials in solution and the process is therefore screened by concrete walls. It takes place in a concrete cell nearly 200ft high, standing on a concrete mat similar to the mat supporting each pile. Around this cell is a steel framework clad with concrete and glass windows to form the shell of the building. Intermediate galleries are provided to form working platforms with the necessary motors, control panels and instrumentation. Openings are made in the inner concrete cell to allow for the entry of equipment and supply pipes. Inside the cell are the separating columns, tanks and vessels for solutions and solvents, and auxiliary equipment. The distinguishing characteristic of this part of the Windscale plant is that the movement and handling of the fluids is effected without the aid of valves or pumps—a fact which greatly simplifies maintenance. A special quality of stainless steel was developed and produced for the pipework columns and containers in this separation plant.

Briefly, therefore, the input to the plutonium separation plant consists of the irradiated uranium slugs, containing some plutonium and fission products. Its output consists of four separated liquids: the first is an impure solution of plutonium (a few pints per ton of uranium slugs); the second is a comparatively large quantity of an impure solution of uranium with a reduced content of 235 isotope; the third is a large amount of impure solvent; and the fourth is a large quantity of highly radioactive fission products in solution.

The plutonium solution is purified and converted into plutonium metal, which is the primary product of the Windscale factory. The uranium solution is also purified at Windscale; it is then sent to Springfields, where it is converted into uranium hexafluoride, and to Capenhurst, where the deficiency in the 235 isotope content is rectified. The remaining two processes at Windscale are the cleaning of the solvent so that it can be re-used and the disposal of the fission products.

There is little that can be said here about the plutonium purification, except that it is done in a smaller plant than the primary separation plant, and that, because of the reduced radioactivity there is no need for heavy shielding. To reduce the fire risk and the danger arising from the poisonous nature of plutonium the whole process is carried out in an atmosphere of inert gas. In the final stages of the purification the volumes being handled are small and, for convenience this part of the plant is of quartz glass,



The Windscale piles. The rectangular filter panels can be seen in the wall of one of the blower houses. The two piles, each with its chimney, blower houses and cooling ponds form a symmetrical layout

shielded by " Perspex " cabinets. This form of construction allowed for flexibility of layout and ease of erection, which were important considerations at a time when the process itself was still in the stage of development.

Effluent Disposal

The methods of effluent disposal in use at Windscale depend on the degree of activity. Those effluents that contain most of the fission products are classed as highly radioactive ; as there is no known means of reducing their radioactivity except by natural decay, they are pumped into large closed tanks which are lined to resist corrosion, and there they are stored indefinitely.

The effluent of medium activity is similarly stored but only for a limited time (say, two or three years) until its activity has decayed to the levels of the low activity effluents. It is then mixed with the latter and disposed of by pumping out to sea.

The effluents of low activity come from the pile cooling ponds, the laboratories and change rooms as well as from the separation plant. First the acids in these effluents are neutralised and then most of the solids and the radioactivity are removed by passing the liquid through a floc and then through sand filters. The resulting liquid is then ready to be pumped out to sea.

To comply with the required levels of tolerance it was decided to lay two 12in. diameter pipes discharging into the sea about 2½ miles from the factory of which the first half mile was laid on land. The pipelines were fabricated in half-mile lengths, which were made by butt welding 40ft stock lengths and then pulling out to sea each half mile length and butt welding these lengths in turn.†

Medical and Health Services

To give an account of the medical and health aspects of the Windscale factory would be outside the scope of this article. However, we saw enough during our recent visit to enable us to appreciate the progress that has been made towards establishing the manufacture of plutonium at Windscale as a safe industry.

The health of the workers at Windscale is the direct concern of the production department acting in close concert with a well-equipped medical centre and an equally well-equipped health-physics centre. With the help of the advice of these two centres it has been possible to establish a strict routine for safeguarding the health of the workers, particularly against the major hazard in this factory, which is the effect of radioactivity.

In the comparatively short time that the factory has been in operation it has been found possible to relax some of the precautions that were originally thought to be necessary. Originally it was thought that any part of the plant that required maintenance would have to be sealed off permanently. Experience has shown, however, that men wearing adequate protective clothing can enter radioactive areas without hazard. Examples of protective clothing worn by maintenance workers are shown in the illustration on page 742. The " divers " suits shown here are of rubber with detachable headpieces. More freedom of movement is provided by a newer and lighter suit (not illustrated) made of opaque polyvinyl chloride with a transparent headpiece of similar material. When this one-piece suit is being worn it is inflated by compressed air from a portable cylinder, a filter valve being fitted in the back of the suit. This garment covers the feet and surgeon's boots are worn. A specially designed "zipper " waist simplifies the work of putting on or taking off this suit.

In parts of the factory where the danger of radioactive contamination is slight the normal uniform is that shown in two of our illustrations. It consists merely of a white cotton coat or overalls, cap and surgeon's boots of rubber, barrier cream being used to protect the hands. A simple drill has been established for the changing rooms and, after removing the protective clothing the worker washes his hands and then checks his hands and feet in a monitor which gives an indication of the level of radioactivity.

The monitoring system includes the use, where necessary, of numbered badges containing sensitive film, which is afterwards developed and compared with calibrated specimens to determine the radioactivity to which the wearer has been subjected. Routine monitoring of all the employees includes a six-monthly medical examination, with blood and urine tests. The medical centre is equipped with X-ray rooms, and, because the factory site is somewhat isolated, an operating theatre and a dental department.

One of the functions of the health-physics services is to carry out radioactivity surveys of the countryside around Sellafield to determine the discharge of radioactivity and its effect on flora and fauna and to exercise control of the discharge accordingly. These surveys over land and sea were started before the factory was built so that the subsequent studies could be strictly comparative.

The land surveys are made by a fleet of vans specially equipped with sensitive radiation monitors ; to establish a basis of comparison the radiation and the amount of atmospheric contamination, as determined by inspiring air through filters, are measured at all the selected sites in the area surveyed. Samples of soil and flora are brought back to the laboratories for examination. At sea the surveys are based on measurements of atmospheric pollution and radiation intensity at sea level, made by a specially equipped motor fishing ship " The Mary Munro III."

† An account of the laying of the effluent pipeline is given in *Britain's Atomic Factories*, Her Majesty's Stationery Office.

Discharge Lamp Factory

About ten years ago a new factory for the manufacture of discharge lamps and other kinds of special electric lamps was set up at Leicester by the British Thomson-Houston Company, Ltd. In the course of a recent visit to these works we were shown some of the latest production techniques and equipment which has been developed for discharge lamp manufacture.

LAST week a Press visit was arranged to the Leicester lamp-making works of the British Thomson-Houston Company, Ltd., in order to show the manufacturing techniques which have been developed in recent years for the production of discharge lamps. These techniques combined with the use of new and improved materials have been responsible for the greatly improved performance now obtainable from the discharge lamps made by the firm.

The works at Leicester were taken over in 1945 specially for the manufacture of lamps, and with the introduction of plant and training of labour, it has now reached a stage where some 500 types of lamps can be made. With the special purpose plant which has been developed and built in the firm's own shops, a high degree of mechanisation has been achieved ; but, as will be appreciated from the following brief description of some of the processes involved in discharge lamp manufacture, much of the work still calls for special skill on the part of the operators.

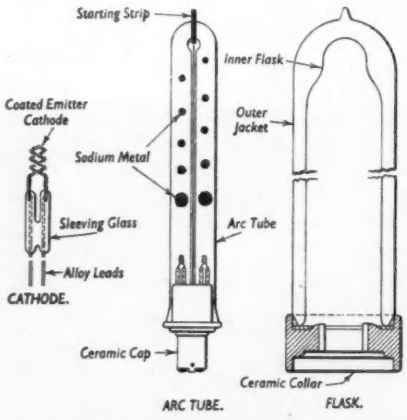


Fig. 1—Component parts of a sodium lamp, showing construction of cathodes and their mounting in the arc tube in which the sodium metal is distributed

The basic design of sodium discharge lamps has not changed since their introduction, although detail improvements have increased their efficiency and lengthened their effective life. One such improvement was the introduction of a special hard glass which allows the use of matching alloy sealing wires and eliminates seal cracks. The component parts of a sodium discharge lamp can be seen in the drawing, Fig. 1. The cathodes for these lamps are formed from coiled thoriated tungsten wire to the legs of which " Fernico " alloy lead wires are welded. This alloy of iron, nickel and cobalt used for the lead wires is virtually impervious to sodium corrosion and matching hard glass sleeves are moulded on to them on special machines to form sound gas-tight seals. After the cathode has been then cleaned in hydrogen it is dipped into the emissive coating solution of barium and strontium carbonates and hydrogen fired.

The arc tubes are of two-ply construction with an inner lining of sodium vapour resistant glass and recently a new machine has been developed to bend these tubes automatically. In this machine the straight lengths of tube are carried over a series of gas jets until the centre section where the bend is made is in a molten condition and sags down as the tube ends are raised. At this point the " V " bend is enclosed in a heated mould and air is blown in from one end to form the bend to the required contour. On being taken from this machine a length of glass tube—known as the stub tabulation—is sealed into the apex of the bend for use at a later stage in exhausting the lamp. After this assembly has been thoroughly washed out the cathode assemblies are placed in the ends of the tube and under heat pinch sealed in position. Before being passed on for futher processing the bend in the arc tube and the pinch seals are annealed under carefully controlled conditions to relieve any stresses.

A dose of sodium in a length of open ended glass tube is then lodged in the tabulation stub mentioned above and the lamp is sealed to the manifold of the exhaust system of the exhausting machine shown in Fig. 2. Each lamp is exhausted on this machine for a long period during which it is " arced " several times to ensure that all traces of impurities in the tube are driven off and pumped away. At the end of this period the sodium in the tabulation is melted by means of high-frequency coils, to be seen at the top of the tabulation stubs, and the metal runs down into the arc tubes. The lamps are then filled with a spectroscopically pure mixture of neon and argon gas and sealed off. To distribute the sodium metal evenly in the tubes they are " arced " to melt the sodium and then shaken by hand.

The mild steel starter strips are then fixed in position and the tubes are capped. The lamps are then aged in a vacuum flask and tested to ensure that they will strike at a voltage below that likely to be encountered under the most adverse operating conditions. The vacuum flasks into which the lamps are fitted consist of a preformed inner glass tube and an outer bulb with its end flared and annealed. An exhaust tube is sealed to the apex of the outer bulb and it is then sealed to the inner tube whilst rotating on a machine. The flask so formed is exhausted and sealed off, after which its ceramic cap is cemented in position.

The construction of the medium pressure mercury vapour discharge lamps of 250W and 400W made in the factory can be seen in Fig. 4. These lamps consist of an arc tube containing a measured quantity of mercury and argon gas at a pressure of about 1 atmosphere. A main electrode is situated at each end of the arc tube and at one end there is a striking electrode for

Fig. 2—Sodium lamps being exhausted in batches of six. During the operation the lamps are "arced" in neon gas to drive out impurities

starting the lamp. The tube is mounted in an outer jacket containing nitrogen.

The cathode coils for these lamps consist of tungsten wire in two helix sizes, having a small pallet of electron emitter material inserted into the inner helix, which is introduced sideways into the outer helix. This assembly is then welded to the two arms of a molybdenum "T"-piece sleeved with glass. The striking or auxiliary electrode at the cap end of the lamp consists of a short length of plain molybdenum wire sheathed in the middle by a special glass having a similar coefficient of expansion.

The bulbs for the arc tubes are made of a special heat-resisting glass and the electrodes are sealed in them by highly skilled glass workers. In this process the dome of the preformed bulb is punctured and a cathode and striking electrode are sealed into the hole. An exhaust tube is sealed in the bulb between the cathode and electrode and then the open end of the bulb is formed into a dome. The second cathode is then sealed in position in this dome after which the tube is pre-exhausted, filled with nitrogen and annealed.

The exhaust machine used for these arc tubes is illustrated in Fig. 3. Before the arc tubes are mounted on the machine a special glass tube assembly is sealed to their exhaust tubes and their ends are painted with liquid "platinised" paint. A side arm of the glass tube assembly is dosed with a measured quantity of mercury, and through this assembly the arc tubes are coupled up to the exhaust system of the machine, as can be seen in the illustration. During their passage round this rotating exhausting, ovening and arcing machine, the lamps are processed and finally filled with spectrally pure argon gas and sealed off. The arc tube with its glass tube assembly on removal from the machine is inverted and the dose of mercury runs from the side arm into the arc tube. The arc tube is then sealed off and detached from the tube assembly.

In the next stage of manufacture the arc tube is mounted between annealed spring steel supporting discs connected by manganese steel wires and mounted on a glass stem. This support assembly locates the arc tube in the glass outer envelope. After a titanium oxide striking resistor and nickel tape connectors have been fitted the assembly is sealed into the outer envelope at the stem flare rim in a similar way to that used with an ordinary tungsten filament lamp. The outer envelope is then exhausted and filled with nitrogen at a controlled low pressure to ensure an inert atmosphere and provide the arc tube with adequate thermal insulation.

A cap is fitted and the finished lamp is operated at rated watts for an ageing period to ensure stability in service. After standing for a period the electrical characteristics and quality of the lamps are carefully tested.

The firm's "M.B." type high-pressure mercury vapour lamps, made in 80W and 125W sizes, have an outer envelope or bulb similar to that of an ordinary tungsten filament lamp. These lamps work on the same principle as the medium pressure lamps, but because of the high operating temperatures and pressure of approximately 8 atmospheres, it is necessary to construct their arc tube of quartz. Because of the very low expansion coefficient of quartz, it is not possible to use a metal lead wire having "matching" characteristics and lead wire assemblies, incorporating a length of very thin, feather-edged, molybdenum or molybdenum tungsten foil are used. The contour and dimensions chosen for such foils provide a permanent vacuum-tight seal to the fused quartz in which they are embedded.

These lead wire assemblies are made by inserting the composite metal leads, with quartz spacing strips for twin seals, into quartz tubes and processing the tubes on a specially designed machine. In this process the seal is made in thirty seconds, during which time temperatures in excess of 2000 deg. Cent. are attained. The seals are withdrawn from the machine and the electrodes welded into position ready to be sealed

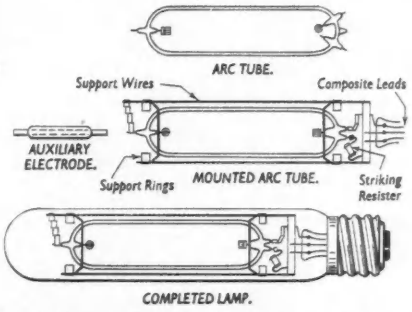


Fig. 4—Component parts of a mercury arc lamp, showing assembly of arc tube in its supports and mounting in outer envelope

into transparent quartz arc tubes on vertical rotary head sealing-in machines. In these machines the seal and transparent body are held together in strict relation, whilst the skirt of the body is melted onto the cathode end of the seal. During this operation an inert gas is passed over the electrodes to protect them from chemical action with the atmosphere. When both electrode assemblies have been sealed into the body the unwanted pieces of tube, which have hitherto protected the seal leads, are cut away and the arc tube is ready to be exhausted. The subsequent arc tube exhaust, mounting, sealing-in and finishing processes are very similar to those used in the manufacture of the medium pressure lamps.

A number of special machines have been developed for the manufacture of tubular fluorescent lamps. On one of these machines the lamp stems, consisting of glass flares, composite leads and pre-cut lengths of exhaust tube, are automatically assembled. A second machine forms the leads and mounts the cathodes, which are covered with emissive coating before the anode plates are spot welded manually to the leads.

The coated tubes for these lamps have the stem assemblies fused on to them and the lamps are evacuated on an exhaust machine. When all impurities have been removed from the tubes they are dosed with mercury and argon gas and sealed off. Two caps are then cemented on the lamps and the lead wires are soldered before the lamps are placed on an ageing machine to stabilise their characteristics.

Fig. 3—Machine for exhausting arc tubes for mercury arc lamps. As the machine slowly rotates, the tubes are exhausted and processed ready for dosing with mercury

Retirement of Sir John Richmond

THE annual report of G. and J. Weir, Ltd., announces the retirement from the board of Sir John R. Richmond, K.B.E. Sir John, who is now eighty-five, has had a long and distinguished association with his company, and for many years has served as its deputy chairman. Tribute to Sir John's work is paid in a statement, accompanying the annual report, by the chairman, Viscount Weir. Viscount Weir recalls that Sir John Richmond saw the starting-up day at Holm Foundry, Cathcart, and from then onward has not only seen the company's development, but has taken a leading part in directing its policy and progress. Sir John's contribution to that progress, the statement adds, has been made with wisdom, humanity and integrity, and, Viscount Weir says, "he has richly earned this rest from official responsibility." Sir John was created C.B.E. in 1918 and K.B.E. in 1939. In 1945, the degree of LL.D. was conferred upon him by the University of Glasgow.

CORYTON OIL REFINERY

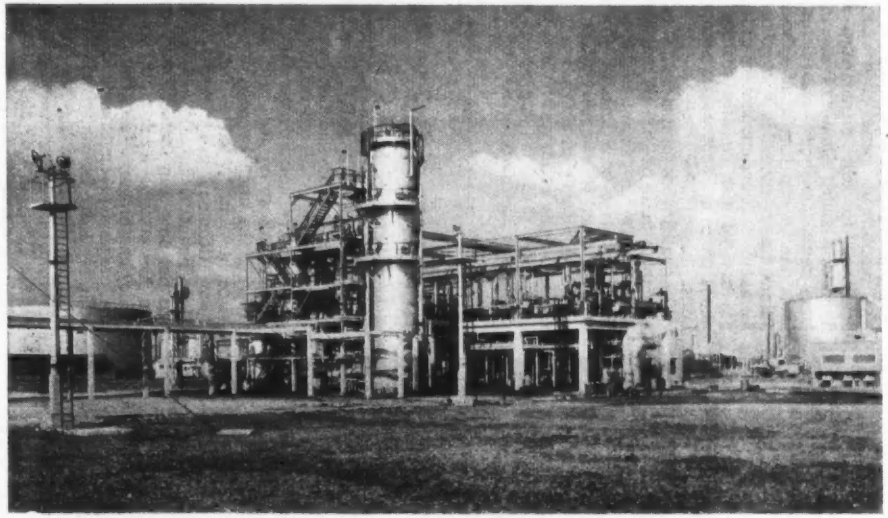


Fig. 1—Propane de-asphalting unit

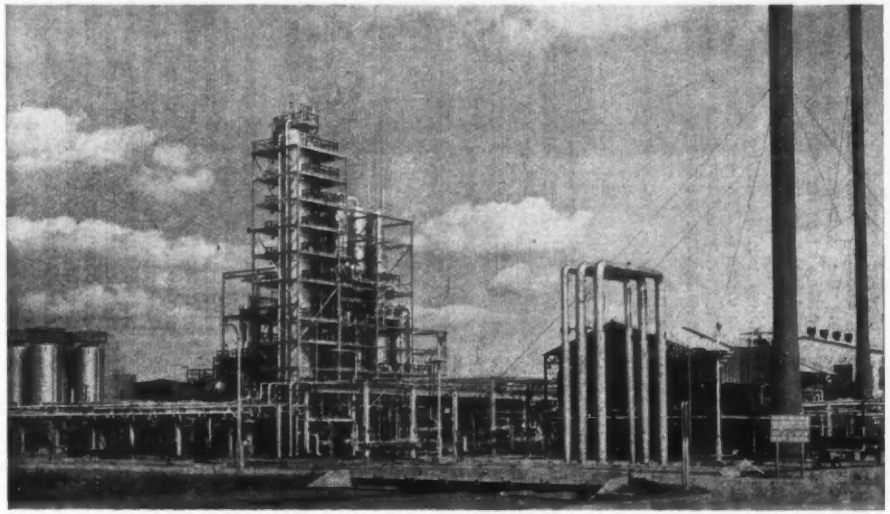


Fig. 2—Furfural treating unit

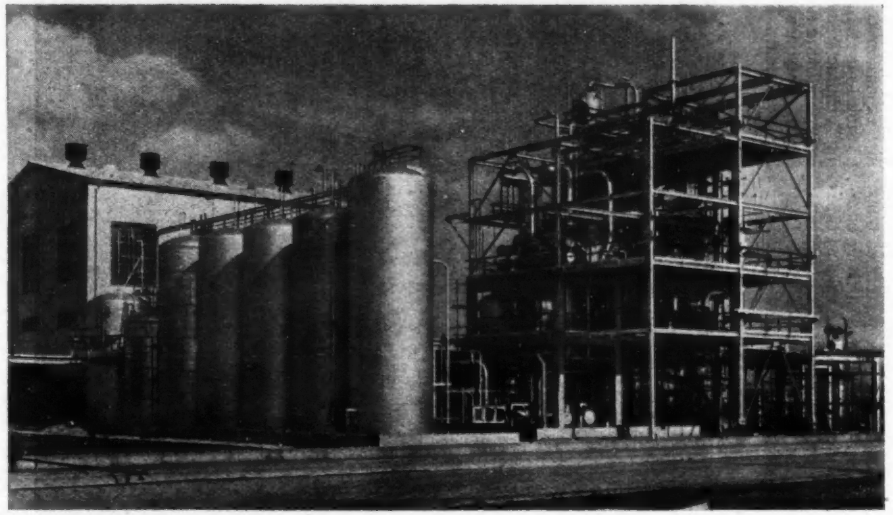


Fig. 3—Methyl-ethyl-ketone unit

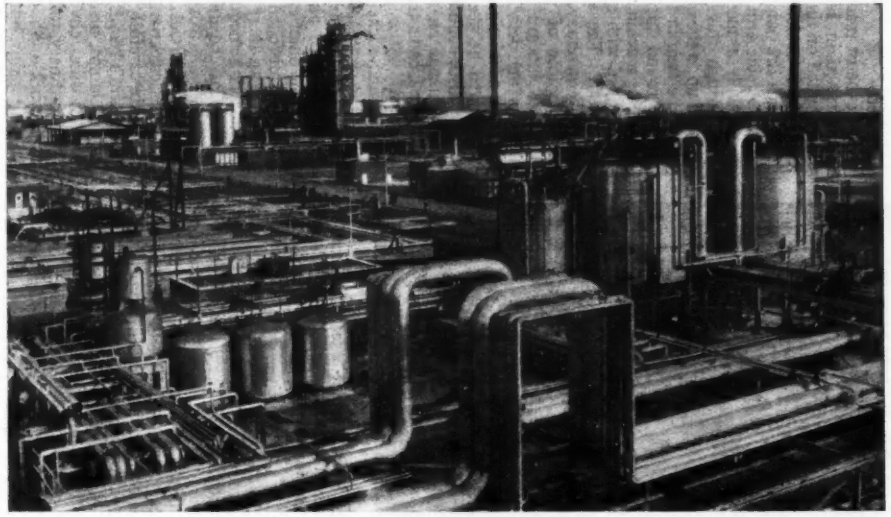


Fig. 4—General view of lubricating units

Coryton Oil Refinery

The formal opening of the Coryton refinery of the Vacuum Oil Company, Ltd., completes a project, started in 1950, to build a refinery having a yearly throughput of 850,000 tons of crude oil. An area of about 200 acres has been developed out of a total of the 1400 acres available, and the plant which has been built in the form of an "L" is equipped to produce lubricating stock oils, high-grade motor spirit, diesel oils, fuel oil and petroleum waxes. The production flow is traced and there are also brief descriptions of the various processes involved.

WHEN Her Majesty Queen Elizabeth, the Queen Mother, performs the opening ceremony of the Coryton refinery on Thursday, May 27th, the event will mark the formal completion of a project which was announced on August 31, 1950, by Vacuum Oil Company, Ltd. The completion of the new refinery marks another addition to the steadily expanding refining capacity within the United Kingdom and follows the pattern of development, dictated by post-war economic circumstances which made it imperative to save hard currency by reducing the dollar content of the oil. This refinery represents a combined investment of British and American capital and is designed for an annual throughput of 850,000 tons of crude oil to produce mainly lubricating stock oils, together with high-grade motor spirit, diesel oils, fuel oil and petroleum waxes.

As planned, the scheme was due to be completed by January 1, 1953, and by that date work was well forward and the distillation unit ready to go on stream. However, the disastrous coastal floods of January of that year caused serious inundation of the site, but this was quickly remedied and the refinery was able to resume operating the two-stage distillation unit within two weeks. During 1953 steady progress was made with the erection and bringing on stream of a number of process units, including the thermal reformer; the "Thermofor" catalytic cracking unit for improving the quality and increasing the quantity of the petrol; the propane de-asphalting unit; the furfural treating unit; the M.E.K. dewaxing unit; the "Thermofor" continuous percolation unit to produce lubricating oil stocks; the gasoline treating and blending units to produce finished motor spirit.

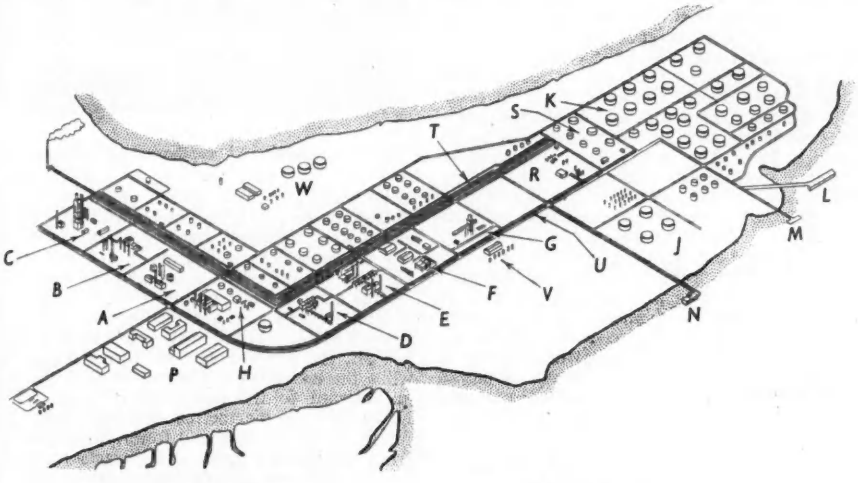
The site chosen for the refinery, on the north bank of the Thames at Coryton, Essex, was generally several feet below the high-water level of the Thames and the ground being partly waterlogged had low bearing values. These conditions called for an enormous amount of work in preparing the ground for building operations and involved tons of gravel and hoggin fill, for raising and levelling the ground, and also the driving of more than 13,000 piles of varying length ranging from 45ft to 65ft. To provide support for the heavy process units and electric generating plant there are 16in by 16in precast reinforced concrete piles, while "Franki" piles cast *in situ*, carry the tanks, buildings and pipe sills.

Layout of Refinery

An area of 200 acres has been developed out of a total of 1400 acres in the refinery scheme, leaving adequate space for any further developments. Our drawing (Fig. 5) of the layout of the refinery shows that the plant has been built in the form of an "L" with the power plant occupying the heel, the gasoline producing units forming the short leg and the treatment units forming the long leg. Run-down storage tanks are arranged opposite each process plant and at the far end of the refining area are the crude oil storage farm and finished product tanks. Many tanks were already in use on the site before the commencement of the scheme and they were incorporated in the development of the area and were moved to new positions by the simple expedient of floating them from one position to another. This was done by impounding water in specific areas by building small dams and then towing the empty tanks drawing less than 2ft of water, to newly prepared foundations.

There is a total of sixteen mild steel fabricated storage tanks, including eight of 56,000 barrels capacity, seven to hold 39,000 barrels each, and one with a capacity of 21,000 barrels. A 24in diameter pipeline with a capacity of 2000 tons per hour transfers the crude oil from the ship's cargo oil tanks to the storage facilities. The incoming oil tankers are moored to a jetty which has been modified so as to take ships of 32,000 tons deadweight and the oil is transferred by means of the ship's pumps. Finished products can be shipped outward via the same jetty and lubricating stock oils will be shipped by the 1640 tons deadweight coastal tanker "Vacuum Pioneer," which was built last year by the Grangemouth Dockyard Company, Ltd., to the company's compounding works at Birkenhead. Barges, loaded at a barge jetty, will perform the same service for the Wandsworth works.

For the storage of gasoline there are a number of floating roof tanks, including three of 6000 barrels capacity between the stages of the gasoline treating unit and four of 22,000 barrels capacity which serve as run-down tanks from the gasoline treating unit before the blending stage. Three tanks, each having a capacity of 30,000 barrels, are for gasoline blending, and the finished product is stored in four tanks, each holding 61,000 barrels ready for shipment. Other tanks vary in size from 20,000 to 40,000 barrels, for the lubricating oil intermediate storage, to comparatively small units of 3000 barrels capacity, while for fresh water storage there is a 61,000-barrel tank.



A—Two-stage distillation unit.
B—Thermal reforming unit.
C—"Thermofor" catalytic cracking unit.
D—Propane de-asphalting unit.
E—Furfural treating unit.
F—"M.E.K." dewaxing unit.
G—Percolation unit.
H—Boiler plant and electrical generators.
J—Finished product tanks.
K—Crude oil storage.
L—Barge jetty.
M—Tanker jetty.
N—Water intake jetty.
P—Administration block.
R—Motor spirit treating unit.
S—Motor spirit blending unit.
T—Products pipe track.
U—Cooling water pipe track.
V—Wax packaging plant.
W—Water purification plant.

Fig. 5—Layout of Coryton refinery

Process Units

In the flow chart (Fig. 6) can be seen the various processes to which the crude oil is subjected to convert it into a large number of end products designed to satisfy modern demands, and we reproduce photographs of several of the process units. All refining is based upon the distillation of crude oil into its various fractions, and at Coryton there is a two-stage distillation unit consisting of an atmospheric tower and a vacuum tower with a capacity of 21,500/11,000 barrels per day respectively. From the tank farm the crude oil is pumped to the atmospheric distillation tower by means of two 1000 barrels per hour Pulsometer pumps, one of which is a standby, each driven by a 350 h.p. electric motor. On its way the oil runs through tubular heat exchangers in which the products of the distillation unit serve as the heating medium and raise the temperature of the oil to about 360 deg. Fah. At this temperature the oil passes through a pipe still heater having convection and radiant heating banks and arranged for firing by oil fuel or refinery gas. After passing through the coils of piping lining the brick furnace the crude oil leaves at a temperature of approximately 600 deg. Fah. and is piped to the atmospheric tower which is 12ft in diameter and 82ft high.

The tower operates on the bubble tray principle and is designed, depending upon the origin of the crude oil, to reduce the charge to a 40 or 50 per cent residual fraction. The oil, partially vaporised, enters the tower at a point near the bottom and becomes cooler as it rises towards the top, a process which is aided by the introduction of steam. The various fractions have different boiling points and as the oil vapour rises and gradually cools the fractions condense at the appropriate level to give the following side cuts:—Light gas oil, kerosine, naphtha, straight run gasoline and gas at the top, while the residual oils collect at the bottom.

Corrosion is a factor which has to be contended with and as a safeguard and a measure of prevention caustic soda is injected into the oil stream before heating. The oil already contains ammonia which it receives before being taken into storage from the oil tankers.

The bottoms from the atmospheric tower are pumped through a pipe still where the temperature is raised from 580 deg. Fah. to about 700 deg. Fah., then the partially vaporised oil enters the vacuum distillation unit. This is a tower of 19ft diameter rising to a height of 100ft, and, as in the atmospheric column, is fitted with bubble trays made of a special alloy. Again the gas rises in the tower and is distilled off into fractions at the corresponding temperature and resulting cuts are waxy gas oil, spindle oil, light neutral oil, heavy neutral oil, the three latter cuts being raw lubricating oil distillates. The residual fraction, amounting to about 50 per cent of the charge to the vacuum column and 25 per cent of the crude oil charge, collects at the bottom. All cuts, except gasoline, from the atmospheric and vacuum columns go to steam strippers in order to ensure and maintain a

clear cut between them by vaporising off the light elements which are returned to the column. The gasoline is stabilised in a small distillation column and all cuts are pumped to intermediate storage tanks.

The residue from the vacuum column is pumped from its intermediate tank to the propane de-asphalting unit (Fig. 1) in which liquid propane from cylindrical tanks, where it is stored under pressure, dissolves the oil in the residue to leave the asphalt. The propane is recovered from the oil and from the asphalt in separate recovery systems and the asphalt is used later as boiler fuel. The oil, known as bright stock, together with the other three raw lubricating oil distillates, goes to run-down tanks from which a header pipe leads, to the furfural extraction unit. This particular arrangement allows each grade of oil to be processed separately, on the block operation system, through the various units, between each of which is a set of eight run-down tanks.

In the furfural unit (Fig. 2) the part of the stock having high lubricating qualities is separated from that having low qualities through the medium of furfural, which is a chemical by-product from a grain process and in which the low quality stock is soluble. Oil and furfural are mixed in an extraction tower to produce raffinates and extracts. The raffinates which are not soluble in furfural are the good quality stock, while the soluble extracts represent the stock of poor quality. Both stocks pass through furfural recovery systems and the raffinates move on to the methyl-ethyl-ketone dewaxing unit, in which a solvent process is carried out, the solvent being a mixture of methyl-ethyl-ketone and toluene. The oil and solvent are chilled to about 0 deg. Fah. in a refrigeration plant, using propane as a refrigerant, and the mixture passes through filters to give oil plus solvent and wax plus solvent, and both mixtures are treated to recover the solvent and leave the oil and the wax.

From the methyl-ethyl-ketone unit (Fig. 3) the oil goes to storage tanks and then to the "Thermofor" percolating unit (Fig. 7), which is understood to be the first commercial unit of its pattern in the world, its function being to remove coloured bodies and unstable constituents as a final refinement of the oil and as a safeguard against possible deterioration at a later date. The system can be briefly outlined as follows :—Clay in a hopper is allowed to fall by gravity into a percolator vessel, where it forms a slowly moving bed through which the oil is passed in an upwards direction. From the percolator the oily clay drops into a naphtha wash tower where the oil is removed and the clay is then dried, in a dryer fitted with steam heating coils, and delivered by elevator to the top of a "Thermofor" continuous kiln from the bottom of which the clay is returned to the hopper ready to be used again. The finished lubricating oil stocks from the "Thermofor" continuous percolation unit are transported by tanker to Birkenhead and by barge to Wandsworth for final blending.

The straight run gasoline goes direct to the gasoline treating unit and then on to the gasoline blending unit. Naphtha from intermediate tanks is pumped to the thermal reformer where, under a high temperature of the order of 1000 deg. Fah. and a pressure of 750 lb per square inch, it is cracked into gas, reformed gasoline and a heavy oil. The reformed gasoline forms a second source of supply and the "Thermofor" catalytic cracking unit (Fig. 9) which treats feed stock consisting of a mixture of light gas oil from the atmospheric column, waxy gas oil from the vacuum column, extracts from the furfural treating unit, and excess wax from methyl-ethyl-ketone unit provides a third source of gasoline. Each gasoline is treated in a separate section of the gasoline treating unit, each section consisting of two stages. In the first stage the gasoline is treated with caustic soda to remove the hydrogen sulphide and in the second stage with a "Solutizer" which dissolves out the mercaptans. The "Solutizer" is regenerated by air blowing. In the gasoline blending unit the three gasolines, which have different qualities with respect to octane number, are blended together in correct proportions to give two qualities of gasoline, namely, "Mobilgas Special" and "Mobilgas." Anti-knock compound is added to raise the octane number and also a number of other additives.

The "Thermofor" catalytic cracking plant at Coryton is the first to be built in this country and the charge stock after passing through a pipe still enters a flash tower to generate gas and oil, both of which are fed into a reactor into which a silica-alumina catalyst, in pellet form falls in a constant stream and cracks the molecules of the feed stock at a temperature of about 850 deg. Fah. The catalyst beads, which have acquired a coating of carbon, fall in a kiln to which heated combustion air is delivered at a rate of 25,000 cubic feet per minute to burn off the carbon. After the removal of the carbon the regenerated catalyst drops into a lift pot and is raised to the hopper at the top of the 270ft high unit by a stream of air which is supplied at 14,500 cubic feet per minute. The temperature in the kiln or catalyst regenerator is approximately 1300 deg. Fah. and this heat is put to useful work in raising steam. Water is passed through coils in the kiln to raise wet saturated steam which eventually collects in a drum as dry saturated steam at a rate of 60,000 lb per hour and is used to supply the turbines which drive the Howden fans delivering the combustion air and lift air. The cracked gases from the reactor enter a fractionating tower to give cuts of gas, cracked gasoline, distillate fuel oil and heavy fuel oil. Mixed with kerosene and light gas oil, the distillate fuel oil forms diesel oil, while the heavy oil and some distillate fuel oil go forward to the fuel blending unit. The heavy oil from the thermal reformer, light gas oil from the atmospheric tower, waxy gas oil from the vacuum tower and extracts from the furfural unit are also forwarded to this unit to produce fuel oils according to blend.

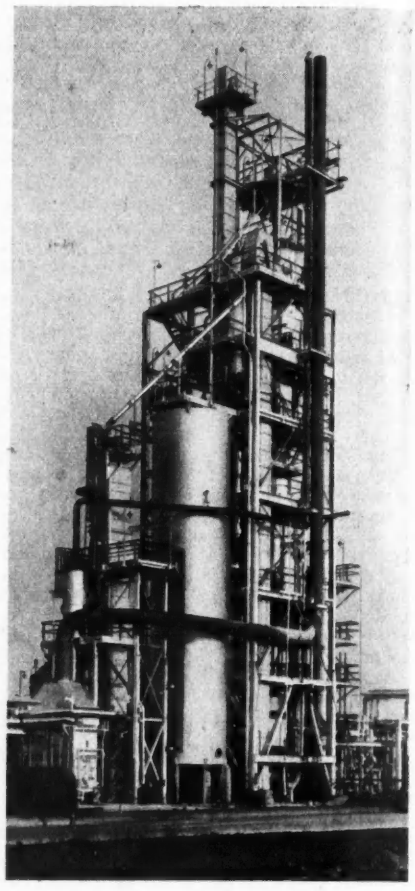


Fig. 7—"Thermofor" continuous percolation unit

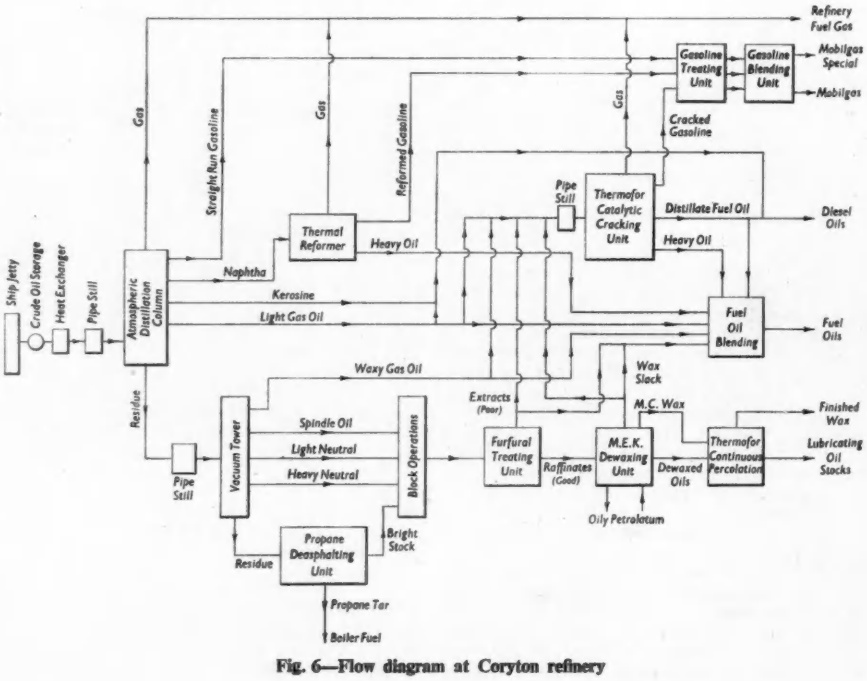


Fig. 6—Flow diagram at Coryton refinery

Refinery Services

Electrical power for the refinery is generated by three 11kV Metropolitan-Vickers generators rated at 5000kW with a power factor of 0·8 and driven at 3000 r.p.m. by a single-cylinder impulse turbine which takes steam at 615 lb per square inch and has double pass-out steam at 125 lb per square inch and 20 lb per square inch. The turbine unit includes surface condensers and two-stage, steam-operated air ejectors. Two alternators are sufficient to carry the power loading and the power is fed to nine substations, where it is reduced from 11,000V to 3·3kV or to 415V and 240V. The necessary steam is supplied by three three-drum vertical water-tube boilers, built by International Combustion, Ltd., having water-cooled furnaces and a maximum continuous rating of 180,000 lb per hour. The designed pressure is 760 lb per square inch and the working pressure 615 lb per square inch, and the steam is superheated to 750 deg. Fah.

There is a kerosene fuel system for starting up the boilers, which are arranged to burn fuel oil, propane tar and refinery gas, all of which can be burnt at the same time, under automatic control. Bunker "C" fuel oil is used and the propane tar, which is maintained at a temperature of 250 deg. Fah. in a storage tank fitted with heating coils, supplied with steam at 125 lb

per square inch, is raised to about 450 deg. Fah. in six-pass tubular heaters supplied with steam at 600 lb per square inch and 750 deg. Fah. Gas from the atmospheric tower, the thermal reformer and the "Thermofor" catalytic cracking unit is collected in a sphere of 35ft diameter which acts as a pressure gasholder. The boilers begin to burn gas in a ring burner by spill over at 37 lb per square inch and are fully operational at 50 lb per square inch pressure.

Air for the boilers, which operate under Howdens induced and forced draught systems, is preheated in a Howden Ljungstrom preheater. Each forced draught fan, driven by a 254 b.h.p. motor, has a capacity of 55,900 cubic feet per minute at 12·75in water gauge and each induced draught fan is rated to deliver 86,700 cubic feet per minute at a pressure difference of 18·6in water gauge. The supply of feed water is automatically controlled by the steam flow from the boilers and the water level in the drums. There are three Sulzer turbine-driven centrifugal boiler feed pumps each capable of delivering 960 gallons per minute against a pressure of 800 lb per square inch, and for starting up there is a motor-driven pump rated to discharge 100 gallons per minute against a pressure of 1000 lb per square inch. A water-treatment plant is provided to deal with the feed water supplies and the raw water, supplied by the East Essex Waterworks Company, is mixed with a hot lime softener and steam at 20 lb per square inch to remove the silica and partially to remove the oxygen. Afterwards the water is further treated by a hot Zeolite process which brings the water down to zero hardness. The power plant is fully instrumented and a photograph of the control room is reproduced in Fig. 8.

For the successful operation of the refinery a very large quantity of cooling water is required, and at Coryton arrangements have been made to take the necessary supplies, amounting to 45,000,000 gallons per day, from the River Thames through a water intake jetty. This is a reinforced concrete caisson built on the Mulberry principle, measuring 100ft in length by 53ft in width by approximately 59ft 6in in height above base, and weighing 4200 tons. The caisson was floated to the site and sunk into place. In the riverside wall are two 10ft by 10ft openings through which water is admitted to four pump chambers through a series of screens. On the top deck of the jetty are the pumping units consisting of two 6360 gallons per minute pumps each driven by a 200 h.p. vertical electric motor and a standby unit of the same capacity driven by a 200 h.p. horizontal condensing geared turbine. These pumps supply the cooling water to the boiler plant condensers through two 36in diameter mains. For the process units the cooling water is delivered through two 42in diameter pipelines by two 15,000 gallons per minute lift pumps, each driven by a 650 h.p. vertical electric motor; there is, in addition, a standby unit of the same rating and turbine driven. A chlorination unit is also mounted on the top of the intake to reduce bacteriological effects in the water and prevent fouling of the piping systems.

Cooling water from the boiler plant is returned through two 36in diameter bituminously coated steel pipelines direct to the river, but the water from the process units requires treatment before being discharged. The latter effluent is directed to skimming tanks and the skimmed water is returned to Holehaven creek, while the oil skimmings are forwarded to an A.P.I. separator, which also treats oil tanker ballast water and oily water from the blowdown pit to separate the oil from the sludge. An oil recovery system, consisting of water separators and emulsion treating units, together with associated settling tanks, recovers the oil which becomes part of the feed stock to the "Thermofor" catalytic cracking plant. The separated water is piped to the moat where it is joined by surface drainage water and sewage disposal water and before release to Holehaven creek the water passes through a final skimmer, the oil skimmings being returned to the A.P.I. separator. For fire-fighting purposes there is a 10in diameter ring water main in which water is made available at a pressure of 150 lb per square inch, the necessary power being provided by a pump driven by a 100 h.p. electric motor and rated to deliver 833 gallons per minute, while there is another pump powered by a 65 h.p. turbine acting as a standby.

Three Alley and Maclellan two-stage compressors, one of which is a standby, are located in the boiler-house and driven at 322 r.p.m. by a 170 b.h.p. electric motor. Each unit, which has fresh water intercooling and salt water after cooling, can deliver 750 cubic feet of free air per minute at 100 lb per square inch pressure, and this is reduced to 50 lb per square inch for use in pneumatically operated instruments, the air for this service being passed through Birlec dryers.

To meet the extensive needs for maintenance of the refinery there is a large building which houses well-equipped workshops which have every facility for instrument maintenance and for carrying out the repair of any part of the refinery plant when the need arises. There are also a building to take stores and excellent laboratory facilities for carrying out tests concerned with the process work and with the finished product.

The principal contract for the construction of the refinery was placed with the Lummus Company, Ltd., and the main contractors, in addition to those already noted, include Costain-John Brown, Ltd., for the mechanical engineering work; John Laing and Co., Ltd., for the civil engineering work; Foster-Wheeler, Ltd., for the distillation unit; tanks were mainly the responsibility of W. Neill and Son (St. Helens), Ltd., and Whessoe, Ltd. Stewarts and Lloyds, Ltd., supplied most of the piping; William Kenyon and Sons, Ltd., carried out the lagging, and pumps were provided by Pulsometer Engineering Company, Ltd., Gwynnes Pumps, Ltd., Sigmund Pumps, Ltd., and Dawson and Downie, Ltd.

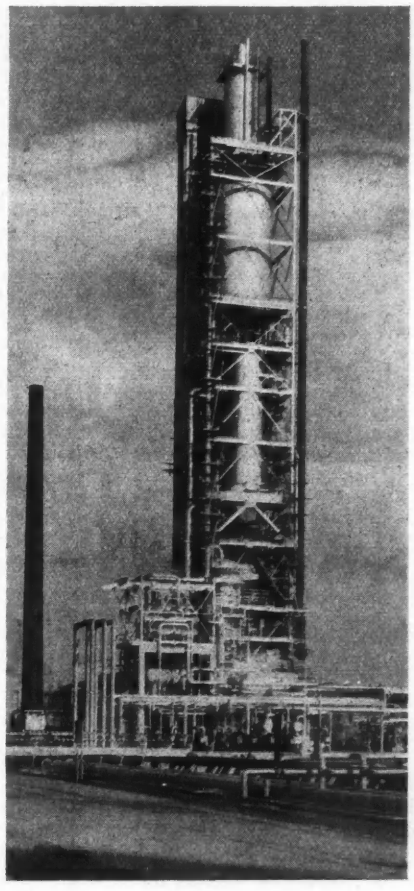


Fig. 9—Air-lift "Thermofor" catalytic cracking unit

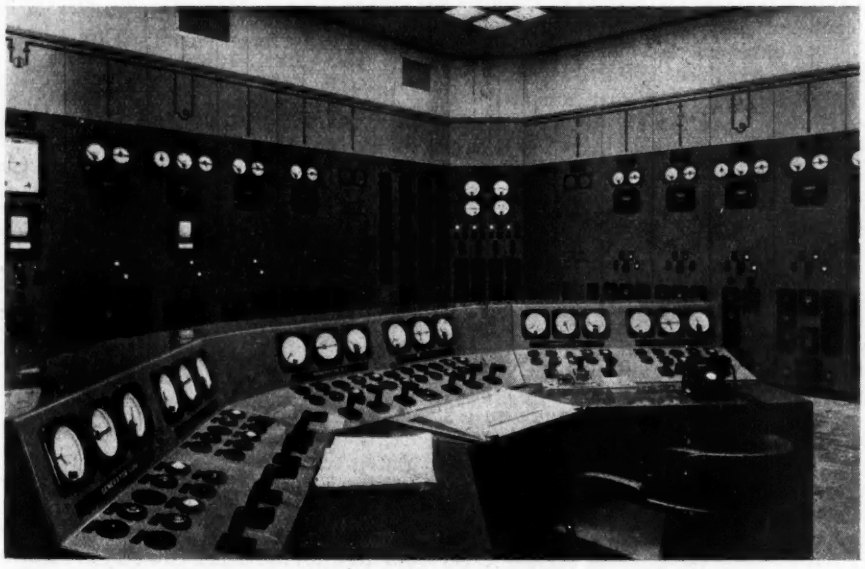


Fig. 8—Power plant control room

Railway Serving the Port of Tema, Gold Coast

THE ceremonial opening of the Achimota–Tema–Shai Hills Railway, which took place on May 11th, marks the virtual completion of the preliminary works, for the new port of Tema, in the Gold Coast. The railway, which is some 40 miles in length, will be used first to convey materials and machinery for the main harbour works. Afterwards, the Achimota–Tema section will serve the port as the connecting link with the main railway network of the Gold Coast, while the Tema–Shai Hills section will constitute the first stage of the railways needed for the development of the Volta River project. The railway has seven reinforced concrete bridges and about seventy culverts, and has called for some 1,250,000 cubic yards of earthwork. Modern earth-moving machinery, including 20-cubic-yard tractor-scraper units, was employed on this work. The line has taken about eighteen months to construct, at a cost of about £1,500,000. The consulting engineers were Sir William Halcrow and Partners, and the contractors were, for the Achimota–Tema section, Taylor Woodrow (West Africa), Ltd., and for the Tema–Shai Hills section, George Wimpey and Co., Ltd. Taylor Woodrow, Ltd., is also building a 50-mile railroad between Achimota and Tema, for which the consulting engineers are Messrs. Rendel, Palmer and Tritton.

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THE HAPPY SCHOLAR

What a remarkable and enlightened tribute to the qualities and achievements of the late Dr. H. W. Dickinson was that Memorial Lecture delivered by Dr. Charles Singer before the Newcomen Society on Wednesday of last week! There is nothing at all noteworthy about the facts of Dr. Dickinson's life. Nor was there anything at all remarkable about his person. He was easily lost in a crowd. But how very different this seemingly commonplace man became once a conversation had been opened, particularly should that conversation relate, as it often did, to the history of engineering! How effective and lucid he could be in addressing a meeting on some facet of his chosen subject! How far above the commonplace he stood in his conception of the value of studying and understanding engineering history and how effective he was in putting history across to other men with far less knowledge than himself! It was indeed his success in interesting engineers in engineering history that was his great achievement. There had been others before him who had written about that subject. There were others whose knowledge and scholarship were comparable with his. But the "happy scholar" as Dr. Singer termed him, had an infectious enthusiasm all his own. We owe it particularly to him that engineers in general, through the perusal of the particularly readable books he wrote, through his work at the Science Museum and for the Newcomen Society and through his personal contacts with many men, became properly aware that engineering had an entertaining and instructive history and that it was valuable as well as interesting to know something about it. If any one man more than another was the creator of the Newcomen Society it was Dr. Dickinson. For it was his infectious enthusiasm that lay behind its foundation and made it a success.

Nowadays, of course, the influence the development of technologies has had upon social life is pretty well recognised. It is a portent that since the war almost every Government in the world has begun actively to encourage industrial growth and technological advance. It is, indeed, difficult to realise that only some thirty or forty years ago the situation was wholly different; and that a very big change in the assessment of the relative importance of the arts, the sciences and the technologies has taken place within the short space of time of this present century. Long ago, of course, there were a few bodies and individuals who foresaw how great the impact of technology could be on human society. The Royal Society of Arts, for example, was making awards for inventions in the useful arts in the eighteenth century; and Prince Albert was impressed by the need for the improvement of technical education in the nineteenth. But the perception was very far from general; and at the opening of this century the "Classics" still ruled supreme in general approbation as the finest form of education. Amongst the academic, even pure science, far less a technology, was still not regarded as a study fitting a man for the foremost administrative posts. Now it is as often preached that a full education cannot be attained by a study only of the Classics, as it is that scientists and technologists pay too little attention to the arts and the humanities. Many things have contributed to this change. Maybe one of them was the discovery that this modern upstart, technology, has a history of its own of reputable antiquity demanding scholarship for its study. If so, Dr. Dickinson himself had something to do with bringing about the change. Nor has the wheel even yet turned full circle. Dr. Singer remarked: "I suspect that, at least since the era of mass production . . . economics have been more dependent on technological factors than has technology on economic factors." It is unquestionably true that what can be done technologically at any given time is largely dictated by economics. But is it sufficiently realised how technological advances can in themselves alter the economic climate? Do our Rulers yet appreciate sufficiently fully how great are the effects of technological changes upon the development of societies? Would not a historical study of the manner in which the social life of this country over the last two hundred years has been moulded and directed by discoveries in technologies give guidance, for example, to administrators of Colonial territories such as Uganda, Rhodesia, Nyasaland and Nigeria, where eras of rapid industrialisation are likely to be ushered in through the harnessing of hydro-electric power?

Immediately following its birth, the Newcomen Society, that Society with which Dr. Dickinson's name is indissolubly connected, had much to do. Its meetings, its transactions and its doings attracted wide attention. For through the work of its members there was being discovered and recorded in broad outline the history of engineering invention and the personalities of the pioneers. But that work is now done. There remains the collection, not of further material of wide general interest, but the collation, the recording, the cataloguing of minutiæ, the discovery of detail, the compilation of statistics. This work is of high value; but it is work for the specialist in the field; and it is work of no wide interest to technologists. These are the dry bones of fact and figure, without whose support no theory or opinion can win acceptance; they are not a stuff that can set the Thames on fire. But Dr. Singer pointed out another and a livelier road along which the Society might travel. "What an interesting history could be produced on anonymous lines, especially a history of technology or of science. It should mention no names at all, but discuss merely achievements. Such a history could explain how discoveries and inventions are related to, and indeed are part of, the social scene of each successive age. . . . It should be one of the tasks of a society devoted to the history of engineering and technology to present its material as an intelligible and connected whole which may be fitted into the general historical background." It is by branching out along that road that, we think, the Newcomen Society could best serve its own objects. But how sadly, in doing so, will its members miss the scholarship and the enthusiasm of Dr. Dickinson!

THE ESSENTIAL PROBLEM OF THE HYDROGEN BOMB

Rather over six months ago we learnt of the Russian claim to have been successful in the endeavour to build a thermo-nuclear bomb, and in our issue of September 18th last we surveyed the possible consequences of the great rival Powers being able, both of them, to include the hydrogen bomb in their armouries. This kind of atom bomb, different in many respects from its uranium-based predecessors, derives its explosive power from the fusion of light elements in the periodic table instead of the fission of one or other of the heavier of them. But it does not seem to possess the advantage of the fission process that it can be used for the generation of power in the days to come when our stocks of fossil fuel begin to run low. Moreover, whilst the smallest size of the uranium bomb is on the whole rather too large for the highest efficiency in military use, the hydrogen bomb threatens to show this defect in even greater degree, in addition

to being apparently quite useless for any civil application.

Recently there has arisen a feeling of widespread dismay at the damage done to certain fishing boats and their crews immediately after some American experiments with hydrogen bombs over a wide test area in the Pacific Ocean. This unfortunate occurrence was, it seems, due to a shower of radio-active dust being carried a great deal further from the scene of the test than the meteorologists among the investigators had forecast as being at all likely. The public, however—whether they happened to be professional politicians or simple voters—seem to have supposed that this mishap was due, not to an error in forecasting the wind, but to the bomb itself having produced a very much more potent explosion than the nuclear physicists concerned had the ability to predict. There followed in due course an excited debate in the House of Commons, much political agitation in Japan, numerous press articles everywhere, and not a few pulpit utterances. Much of what was then said would have been vastly more informative had the speakers taken the trouble to inform themselves of what had already been published on the subject during the last three or four years—such, for instance, as Professor Sir George Thomson's short paper on "Hydrogen Bombs: the Need for a Policy," in the issue of the Chatham House publication "International Affairs" in October, 1950. That was an expert presentation of the subject which had previously been vetted by a Chatham House "Atomic Energy Study Group," in which science and political affairs were equally effectively represented. It was there made clear that the limit to the potency of such bombs could be precisely predicted and that the possibility of really serious danger on a large scale lay principally in the fact that if certain materials were used, whether by ignorance or malignity, in the choice of the metal casing for holding the bomb together a large portion of the earth's atmosphere might be so radio-actively "poisoned" as to be lethal to a large proportion of the inhabitants breathing it. And in the extreme case this might even result in a situation wherein, to quote Sir George Thomson, "the whole world might be made uninhabitable"; no indication was given of what the metals in the bomb casing would need to be to lead to the bomb having this frightful potency. But in a very recent issue of an American journal there appears—perhaps as an "authorised leak"—a description of a novel variety of hydrogen bomb in which the casing contains the element cobalt, and it claims that the radio-active cloud resulting from its explosion could "travel with the prevailing winds over distances of thousands of miles, destroying all life in its path."

The forecast made by Sir George Thomson in the Chatham House publication already cited, taken with this American release concerning the possible use of the element cobalt, leads us to endorse the suggestion made in these columns last September—that the more one learns about the potentialities of the hydrogen bomb the less must reasonably minded people be disposed to object to its use being banned altogether. The uranium explosive could be retained for military use in artillery or in bombs, so long as we needs must arm, with the alternative of affording one day not only a useful, but perhaps quite essential, alternative source of fuel for civil purposes. It has, however, to be admitted that any internationally agreed banning of the thermo-nuclear form of explosive needs the backing of an effective form of international inspection if it is to be generally acceptable. If the present U.S.S.R. Government should refuse to agree to this necessary precaution it is hard to see how any lightening of the world's anxiety on this subject can be attained. Nothing short of a real change of heart, and policy, in Russia itself can avail.

Memorial Service for Mr. E. Graham Clark

A MEMORIAL service for the late Mr. Edmund Graham Clark, C.B.E., M.I.C.E., secretary of the Institution of Civil Engineers, was held at St. Margaret, Westminster, on Monday last. The service, which was attended by a large company of engineers, was conducted by Canon Charles Smyth, and an address was given by the Dean of Westminster. Mr. Graham Clark, who died on April 23rd, had been secretary of the Institution of Civil Engineers since 1937.

Literature

Discontinuous Automatic Control. By I. FLUGGE-LOTZ. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 32s. 6d.

OVER the past number of years a vast body of literature has grown up on the linear theory of servo-mechanisms and automatic control. However, the extension of this theory to non-linear components has not progressed to the same extent and this book offers a graphical analysis of one such system, the "on-off" or "flip-flop" servo. It comes as a result of work done by Mrs. Flügge-Lotz in Germany during the war and continued later at Stanford University. Discontinuous systems as here considered are basically linear over specific time intervals and may thus be solved by the continuous application of linear analysis. This process, however, can be tedious and the author has outlined a graphical approach employing the phase plane so popular in the analysis of general non-linear systems.

The treatment of systems with one degree of freedom is in general detailed and well laid out, starting with the form of the equation and going on to the type of control mechanisms used, although the chapter on the solution of the differential equation might be considered to be somewhat inadequate. Two very thorough chapters follow, introducing the phase plane or graphical approach, one devoted to motion with position control and the other to motion with velocity control. Both follow roughly the same pattern and for a single degree of freedom cover all possible variations in the coefficients of the control equation, and thus form a useful source of reference for any practical discontinuous system of this type which may arise. A useful section is also included on the analysis of possible imperfections in the controlling mechanisms.

Although an analysis of the system with one degree of freedom is desirable and often adequate, the more interesting application arises in practical design problems where a single degree of freedom is not sufficient to describe the system. An approach to this problem on similar lines to that employed in the simple system is given, but whether or not it would ease the computational burden of a linear calculation over specific time intervals is open to question. It would also appear that this approach is unsuitable for application to a higher number of freedoms than three, and the general inference is that, although the case of a single degree of freedom is well catered for, any attempt to apply it to a higher number tends to become unwieldy and outside the domain of textbook investigations.

On the subject of references to the literature this book leaves much to be desired and such workers in the same field as Minorsky and Weiss receive scant mention. This would almost certainly limit its usefulness for those who find it necessary to study the various implications of the analysis.

It will be readily appreciated by those concerned with non-linear problems that the engineer is appealing more and more to the ingenuity of the analogue computor designer at the expense of the analytical approach. This book deals with a problem which can be solved with comparative ease and slide-rule accuracy on an analogue computor which will present the results as a plot against time. Without wishing to disparage analytical effort in this direction, it appears that the general non-linear problem of the present and future will be solved by analogue techniques, and the only place for analytical solution is where extreme accuracy is required.

This is an interesting and complete treatment of the single freedom problem, but the attempt to extend it to higher freedoms is of doubtful value. The main omission is a comprehensive list of references to the numerous other works in the same field.

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BRITISH STANDARD SPECIFICATIONS

SIR,—In your issue of the 14th inst, Mr. Bryan Bateman raises the issue of the justification of the publication of certain British Standard Specifications, an issue which some of us have for some time considered to be ripe for discussion. With your permission I would contribute another example, in a different sphere of production, illustrating what I understand to be Mr. Bateman's objection.

For many years ½in (nominal) bib-taps and stop-taps for water have been produced conforming with the Ministry of Health pattern identified by the "Swan" mark, in which the head-thread diameter has been 0·888in with the usual tolerances. In the recently published B.S. 1010 : 1953 this dimension has been increased to 0·947in ± 0·0038in, thereby destroying interchangeability between the heads of the two designs, for no apparent reason, to the disadvantage of some producers and all consumers and having, no doubt, repercussions also on export trade.

Pending the development of this discussion I refrain from further comment.

A. B. BUCKLEY

Emsworth, Hants,
May 15th.

Books Received

The Modern Diesel. Twelfth edition. By D. H. Smith. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 12s. 6d.

Electrical Measuring Instrument Practice. By E. H. W. Banner. London: United Trade Press, Ltd., Boswell House, 9, Gough Square, E.C.4. Price 15s.

Microscopical Techniques in Metallurgy. By H. Thompson. London: Sir Isaac Pitman and Sons. Ltd., Pitman House, Parker Street, W.C.2. Price 18s.

Questions and Answers on Power Station Practice and Plant. By T. H. Carr. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 6s.

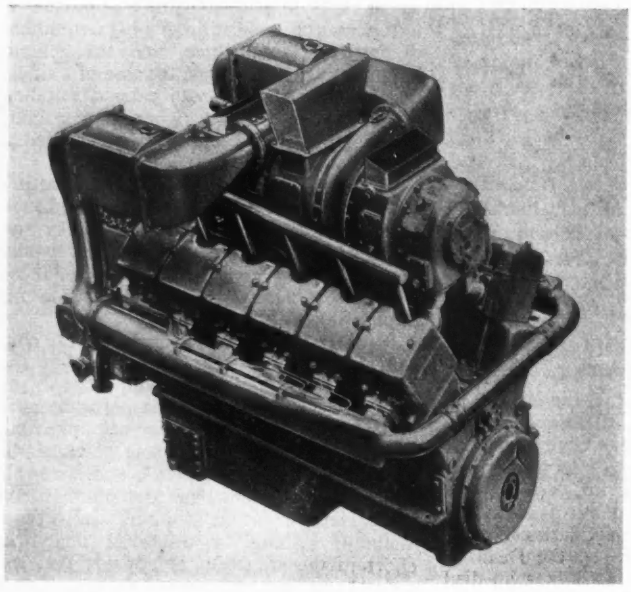


Fig. 8—Twelve-cylinder vee locomotive engine of 59·2 litres capacity developing 1350 h.p. at 1500 r.p.m., with a turbo-supercharger for each bank—Mercedes-Benz

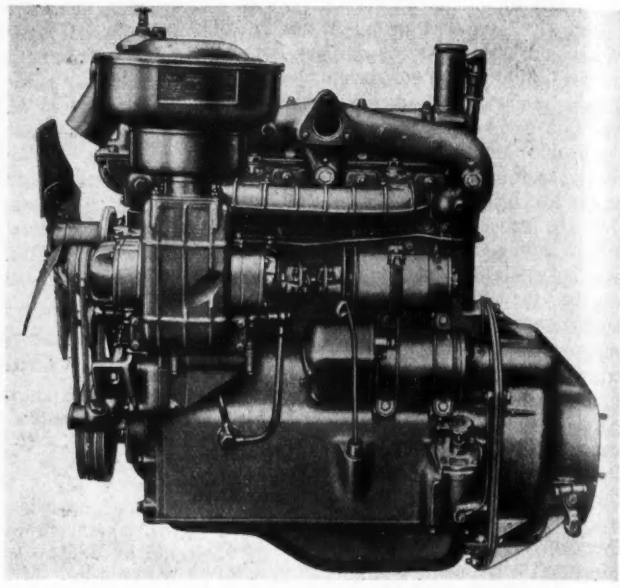


Fig. 9—Four-cylinder tractor engine of 2·8 litres capacity fitted with Roots supercharger and developing 51 h.p.—Hanomag

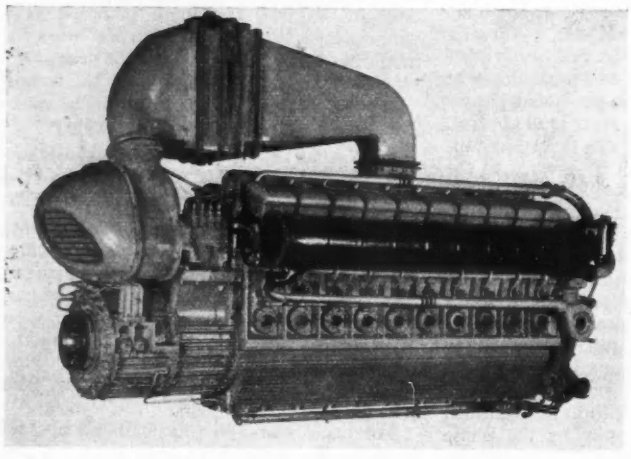


Fig. 10—Twenty-cylinder supercharged engine of 2500 h.p. at 1630 r.p.m. Cylinder capacity is 134 litres (bore 185mm and stroke 250mm)—Mercedes-Benz

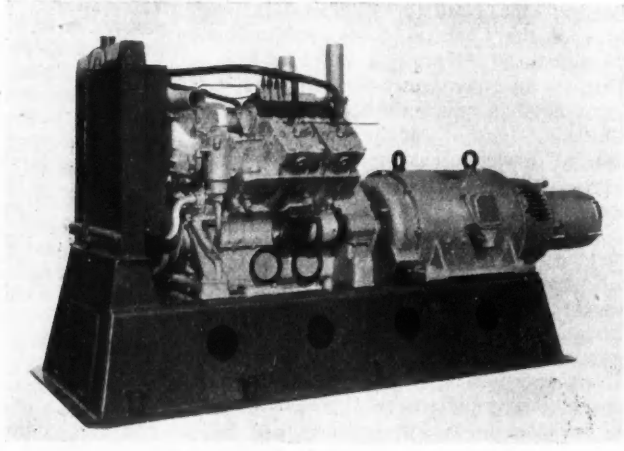


Fig. 11—Four-cylinder, two-stroke vee engine with generator developing 200 h.p. at 1500 r.p.m. Reverse loop scavenging is employed—Jenbacher

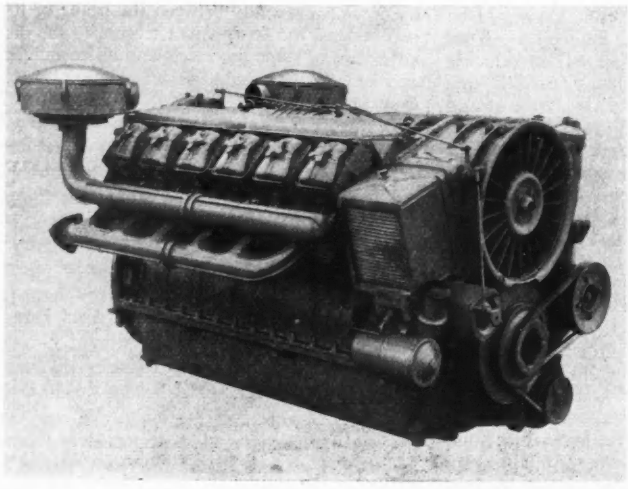


Fig. 12—Air-cooled, twelve-cylinder vee engine of 110mm bore and 140mm stroke, and developing 250 h.p. at 2250 r.p.m.—Deutz

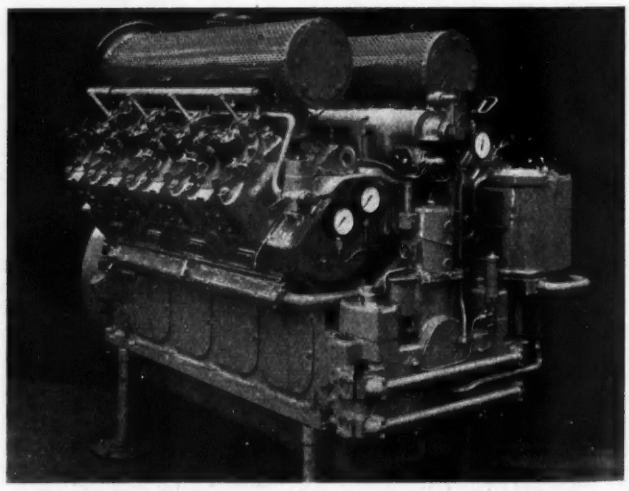


Fig. 13—Eight-cylinder 90° vee engine of 200mm bore and 250mm stroke, developing 435 h.p. at 650 r.p.m.—Deutz

German Industries Fair, Hanover

No. II—(*Continued from page 709, May 14th*)

Internal Combustion Engines

THE West German industry of internal combustion engines was represented by thirty-two German and two Austrian manufacturers in Hall 3, which occupied an area of 33,500 square feet. In addition, an open-air display, considerably larger this year than last, was arranged to demonstrate the many fields of application of internal combustion engines.

The majority of the prime movers shown were diesel engines, and of the few petrol engines displayed most were outboard engines, and such small industrial engines as are being made by motor-cycle and car manufacturers. It is worth noting that about 98 per cent of all power units other than road vehicle engines, are now of the diesel variety and much technical interest centres round the smaller power units in the 2 to 20 h.p. range.

Many of the 260 engines displayed were entirely new and of advanced design, and it was apparent that the West German engine industry is making great efforts to regain its pre-war markets, which in 1938 amounted to about 38 per cent of world production of I.C. engines. There are already indications that the domestic market is approaching saturation and it is reported that some factories are not working at full capacity. The value of exports has also declined with the exception of that of marine engines, which has gone up by 14 per cent. At present the Federal industry seems to be handicapped by rising wages and by the price of basic raw materials, such as steel and cast iron, which are substantially dearer than in Great Britain. Great efforts, therefore, are being made to promote engine designs which combine a high output with the economical employment of material.

Arising from this policy there were among the engines of medium and higher output quite a number of supercharged engines, many of them with a vee cylinder arrangement. Preference given to this cylinder arrangement in German practice arises from the fact that in order to attain a high engine speed cylinder size is limited, and engines built up of higher output from a multitude of cylinders of standard size. It is quite common to build units of up to sixteen cylinders. A typical example of this method can be seen in the case of Klöckner-Humboldt-Deutz A.G. With one standard air-cooled cylinder, this firm manages to build twelve different types of engine ranging from a 15 h.p. single-cylinder to a 250 h.p., twelve-cylinder vee engine (Fig. 12).

The importance of supercharging is well known and need not be expounded. However, progressively more use of high boost pressures combined with intercooling was clearly favoured, and mean effective pressures up to about 250 lb per square inch have been attained under normal operating conditions. Although supercharging at present is confined to four-stroke engines, it is reported that extensive efforts are being made with the object of adopting this system to two-stroke engines.

Turning to the larger engines, i.e. those of more than 200 h.p., there was at the stand of Maschinenfabrik Augsburg-Nürnberg A.G., type "WV 22/30," an eight-cylinder-in-line diesel engine of 220mm bore and 300mm stroke, mainly intended for use in locomotives. The engine, like all M.A.N. diesel engines, employs direct injection and has two inlet and two exhaust valves per cylinder. It has a cast iron crankcase-cum-cylinder-bloc, wet cylinder liners and light-metal pistons, and with a turbo-blower develops 930 h.p. at 1000 r.p.m., or with intercooler 1040 h.p. This engine is a typical example of the economic advantage of supercharging, for compared with the normally aspirated engine, which at an output of 500 h.p. has a unit weight of 21·5 lb per horsepower, the supercharged version with intercooling weighs only 13·7 lb per horsepower.

At the same stand was shown a cylinder of 1200mm bore (Fig. 14) for a gas engine made of welded steel. This construction is

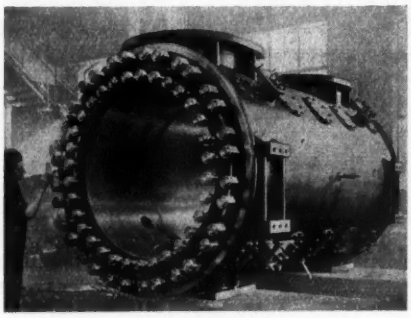


Fig. 14—Welded steel plate cylinder of 1200mm bore for a gas engine—M.A.N.

claimed to be superior to cast iron cylinders, as the cylinder walls can be kept thin, thereby improving the heat flow to the cooling water and increasing the effectiveness of the lubricating oil film.

The Daimler Benz A.G., Stuttgart, showed several interesting supercharged engines, among them the twenty-cylinder Mercédès-Benz marine engine, MB 518, which has its forbears in the engines originally designed for the Zeppelin airships. Redesigned shortly before the war, the type "MB 518" was made in large numbers for use in the fast motor torpedo boats of the German Navy. Although conceived in its present form (Fig. 10) more than fifteen years ago, it incorporates several details of relatively advanced design and is still being exported in considerable numbers. The engine has a high and stiff light metal crankcase with substantial tie rods, which give ample strength and relieve the casting of the reaction forces resulting from combustion pressures and bearing loads. The crankcase carries twenty individual cylinders, which are arranged in vee form at an included angle of 45 deg. The cylinders are made of steel and welded integral with the steel cylinder heads and the cooling jackets. Like all Mercédès-Benz engines, it employs the precombustion chamber system, the chamber being located in the centre of the cylinder head. Two inlet and two exhaust valves per cylinder are operated by push rods and rocker arms from two camshafts which are located on the outside of each cylinder bank. The engine has a cylinder bore of 185mm and a stroke of 250mm (cylinder capacity 134 litres) and develops, in the supercharged version, 2500 h.p. at 1630 r.p.m. It has an optimum fuel consumption of 0·36 lb per horsepower hour, i.e. about the same consumption as a well-designed direct injection engine. This favourable consumption is due to a great extent to the high mechanical efficiency of the engine which has been achieved by employing ball or roller bearings for all the principal bearings of the engine with the exception of the connecting-rod bearings. It also results from the reduction of oil drag by an unorthodox system of individual oil pumps, each supplying a metered quantity of oil to each main bearing.

The supercharger has a double-sided impeller, which is driven by gearing from the coupling end of the crankshaft, and a large cooler in the supercharger trunking passes the heat of compression on to the sea-water system. The engine weighs about 4·7 tons, equivalent to a unit weight of 4·18 lb per horsepower.

Another interesting engine, intended as a marine or locomotive engine, is the type "820 Db," a twelve-cylinder vee 60 deg. engine of 175mm bore and 205mm stroke (cylinder capacity 59·2 litres), which develops 1350 h.p. at 1500 r.p.m. (Fig. 8). The two-cylinder banks are cast integrally with the crankcase in Al-Si alloy, and wet cylinder liners are employed. The pistons are of forged light metal alloy and have three compression rings and two scraper rings. Two inlet and two exhaust valves per cylinder, operated by push rods and rockers from a camshaft inside the vee, are provided, and the connecting-rods run side by side on each crankpin of the case-hardened crankshaft which is carried in nine lead-bronze bearings.

Two turbo-superchargers are fitted in line between the cylinder banks, each charger supplying one cylinder bank. The boost pressure at maximum output amounts to 28 lb per square inch abs., and a maximum brake mean effective pressure of 245 lb per square inch can be attained. The peak pressure in the cylinder under these operating conditions does not exceed 1250 lb per square inch, and the fuel consumption ranges between 0·33 lb and 0·35 lb per horsepower hour. The engine weighs about 3 tons, equivalent to a unit weight at maximum output of 5·01 lb per horsepower. Here again the possibilities of high supercharging are manifest, considering that the output of the normally aspirated engine version having the same cylinder capacity and speed amounts to only 700 h.p. and the unit weight to 7·85 lb per horsepower.

At the stand of Maibach Motoren G.m.b.H., Friedrichshafen, attention centred round the new sixteen-cylinder engine, type "MD 865/870" vee 60 deg. supercharged engine of 185mm bore and 200mm stroke (cylinder capacity 86 litres), which develops 2000 h.p. at 1600 r.p.m. The crankcase is made of welded steel construction and is integral with the two cylinder banks in which the wet cylinder liners are inserted. It forms an undivided tunnel housing for the crankshaft, which is carried in roller bearings. The engine has individual cylinder heads, each being fitted with three inlet and three exhaust valves, which are arranged around a central precombustion chamber, and are operated by rockers from two overhead camshafts per cylinder bank. The cast iron pistons have steel crowns and are cooled by oil, the temperature in the piston ring section being kept well below the point at which ring sticking generally occurs. Each cylinder is fitted with an injection device system "L'Orange," on which the pump and the injection valve are combined in a single unit, thus eliminating the pressure pipes; the injection pumps are operated from the inlet camshaft by means of rocker arms. Also of interest is the construction of the crankshaft, which carries the inner races of the main roller bearing on disc-shaped crank webs, resulting in a very short and stiff crankshaft. The two superchargers

have vertical shafts and are located side by side between the cylinder banks. Intercoolers are generally provided, particularly for marine purposes. The engine at full output weighs about 5·2 tons, which is equivalent to a unit weight of 5·7 lb per horsepower.

In view of the growing popularity of the supercharged four-stroke engine, which, at its present stage of development is quite capable of standing up to mean effective pressures of about 150 lb per square inch, without any excessive thermal stresses, it may appear doubtful whether there is still any scope left for the port-controlled two-stroke engine. Although the brake mean effective pressure of this engine type as a rule does not exceed 70 lb. per square inch, it has, however, the advantage of greater simplicity and lower manufacturing cost. Further, when used as a marine engine, reversing can be attained with comparatively simple means.

Several interesting two-stroke engines were noted, among them a four-cylinder vee engine, type "JW 200 E," of Jenbacher Werke, one of the two Austrian engine exhibitors (Fig. 11). The engine has 150mm bore and 170mm stroke and develops 200 h.p. at 1500 r.p.m. Like practically all two-stroke engines at the Fair, it employs the reverse loop scavenging system and is fitted with a centrifugal blower.

At the stand of Klöckner-Humboldt-Deutz A.G., Cologne, were two newly developed vee 90 deg. engines. The bigger type, "T8M 525" (Fig. 13) has eight cylinders of 200mm bore and 250mm stroke and develops 435 h.p. at 650 r.p.m. The smaller engine, type "TM 320/420," has four cylinders of 160mm bore and 200mm stroke and develops 265 h.p. at 800 r.p.m. A high-speed version of this latter engine, having eight cylinders and developing 400 h.p. at 1100 r.p.m., though not shown at the Fair, is in preparation.

Both engines are similar in their general layout; the cast iron crankcase is integral with the two cylinder blocks and the cylinders are arranged at an included angle of 90 deg. The scavenging air is supplied by a gear-driven centrifugal blower, which is located at the flywheel end of the engine, the air receiver forming part of the engine housing between the two cylinder banks. Both engines have much the same fuel consumption of about 0·350 lb per horsepower hour and the unit weight of the smaller is 17·5 lb. per horsepower hour, that of the bigger one 16·5 lb. per horsepower hour.

At the same stand were shown eleven models of the Deutz air-cooled engines. Of particular interest was the latest addition to this range, a twelve cylinder vee engine of 110mm bore and 140mm stroke which has a maximum output of 250 h.p. at 2250 r.p.m. (Fig. 12). This twelve cylinder engine, which is already being made in numbers at the Magirus Works, Ulm, of the Klöckner-Humboldt-Deutz A.G., is believed to be the biggest air-cooled diesel engine in actual production; it has extended the application of the direct cooling method far into a field so far reserved to water-cooled engines.

Among the numerous engines of less than 200 h.p. output there were also several interesting models of vee form engines and some supercharged power units. In this particular section of medium sized engines it was evident that the development of industrial power units, in their constructional details as well as in their general layout, is becoming more and more influenced by the knowledge and experience gained on aircraft and high-speed vehicle engines. There was, of course, still a sprinkling of slow running engines of orthodox design but the general tendency is directed towards lighter weight, increased engine speed and higher mean effective pressures.

The smallest vee diesel engine at the Fair was exhibited at the stand of Orenstein-Koppel A.G., Dortmund; this 2 litre engine, type "112, V2 O," has two cylinders arranged at an included angle of 60 deg., on a cast iron tunnel casing and develops 25 h.p. at 1800 r.p.m. At the same stand were shown several vee form diesel compressors of two, four, six and eight cylinders. This design, which is also employed by other German manufacturers, utilises one cylinder bank to house the diesel cylinders and the other bank to take the compressor cylinders.

In the category of medium-sized engines turbo-charging was represented only by a six cylinder, 8·3 litres, engine of M.A.N. This engine, of 110mm bore and 140mm stroke, develops in the supercharged version 155 h.p. at 2000 r.p.m., compared to 130 h.p. of the normally aspirated engine. It is considered that the high price of the exhaust turbine makes this method of pressure charging uneconomical for power units of less than about 8 litres cylinder capacity. There are indications, however, that the mechanically driven blower will come into its own as a useful means of increasing the specific output of smaller engines. An example of this design was shown by Hanomag A.G., Hannover, in the form of a four cylinder, 2·8 litres, tractor engine (Fig. 9) of 90mm bore and 110mm stroke which was fitted with a vee belt-driven Roots blower. The supercharged engine develops 51 h.p., compared to 36 h.p. of the normally aspirated engine. The power absorbed by the blower amounts to about 6 h.p., 50 per cent of which is being regained in the engine owing to the reduced work done during the injection stroke. An increased output of 40 per cent has been achieved with an increase in engine weight of only 10 per cent.

When examining the small engines at the Hanover Fair, i.e. the single and two cylinder units of less than 1 litre capacity per cylinder, the diversity of their design was very noticeable, vertical and horizontal engines, water and air cooling, four stroke and two stroke engines competing in the same field. Manufacturers were offering engines of the same capacity either water cooled or air cooled, using as far as possible the same components. In accordance with the general German practice applying to small high-speed diesel engines, practically all water-cooled units employ the ante-chamber principle because of the self-cleaning effect claimed for the single-hole pintle nozzle, and the insensitivity of the precombustion chamber engine to fuels of varying origin and different quality. There is, however, a certain tendency towards employing direct injection for air cooled engines, where the location of cast iron or steel precombustion chambers in the thermally highly stressed cylinder heads has met with difficulties.

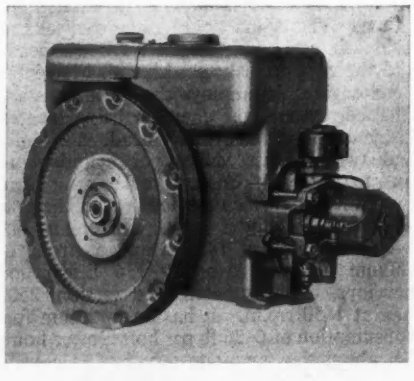


Fig. 15—Hopper-cooled horizontal engine with flywheel condenser. Engine capacity 350 c.c., output 4 h.p.—Farny and Weidmann

An interesting feature is the preference given in Germany to single cylinder, horizontal engines, mostly of the hopper cooled type, for a great variety of mobile and transportable work and in particular for small agricultural tractors. The appeal of these engines results from their self-contained nature and also is to a great extent the outcome of considerable design effort directed towards low weight and compact bulk (Fig. 15). The smallest was a 4 h.p. engine of 75mm bore and 80mm stroke (cylinder capacity 350 c.c.) on the stand of Farny and Weidmann, Lampertheim, near Mannheim. All these engines are fitted with ball and roller bearings throughout and have no

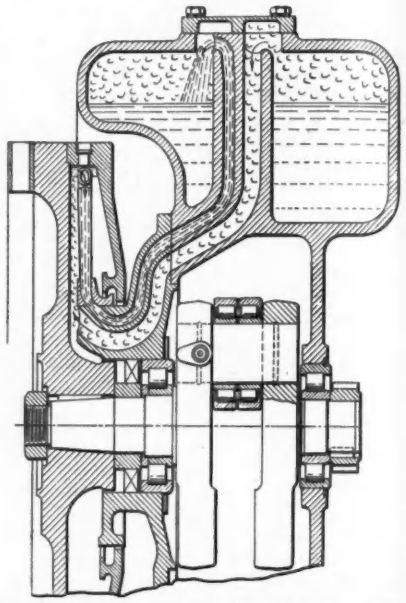


Fig. 16—Arrangement details of a flywheel condenser showing the vapour and liquid circuits from the hopper

lubricating pump. Another interesting item of these engines is the flywheel condenser, a simple but ingenious device which overcomes the main disadvantage of evaporation cooling, namely, the high water consumption and, consequently, the necessity of topping up the hopper at regular intervals (Fig. 16). Vapour, developing at the top of the hopper, is forced down through a passage and enters the flywheel at the hub; it expands in the hollow space inside the flywheel and is condensed on the rotating walls which are sufficiently cooled by a ring of ventilating vanes. The centrifugal force causes the condensate to collect at the rim and the water, forming a rotating annulus at the circumference of the condenser, is returned to the hopper by a stationary scoop, located on the bearing cover. The flywheel condenser reduces the amount of water lost by condensation to about 4 per cent of that consumed in an ordinary hopper-cooled engine.

Lack of space prevents descriptions in detail of some of the latest air-cooled engines, among which was an interesting single cylinder Deutz engine of 90mm bore and 120mm stroke (cylinder capacity 760 c.c.), which develops 10 h.p. at 2000 r.p.m. The engine is fitted with a radial-flow flywheel cooling fan and, in addition to the counter-weighted crank webs, employs a balance weight,

rotating contrariwise to the direction of the crankshaft for the purpose of reducing the primary inertia forces.

Some interesting constructional details could be observed in the class of small two-stroke engines which were shown by six manufacturers. With the exception of the water-cooled 510 c.c. Hanomag engine, type "611," which develops 12 h.p. at 2200 r.p.m. and uses a belt-driven Roots blower as scavenging pump, all other engines employ crankcase scavenging, thereby limiting the attainable brake mean effective pressure to about 50 lb per square inch.

A deviation from the otherwise general practice of using the port-controlled loop scavenging was represented by an air-cooled, two-cylinder engine made by Andreas Stihl, Waiblingen. This 760 c.c. engine of 90mm bore and 120mm stroke has a maximum output of 14 h.p. at 1850 r.p.m., and is unusual inasmuch as it combines the simple crankcase scavenging method with the more elaborate uniflow scavenging system which requires a mechanically operated valve in the cylinder head. The design, though expensive, has the advantage of a higher brake mean effective pressure—about 60 lb per square inch—and avoids one of the setbacks of an air-cooled port-controlled engine, namely, the very high thermal stresses in the exhaust zone which frequently lead to cylinder distortion and coking up of the ports. The engine has a particularly neat and clean outline, as all the major parts—as crankcase, cylinder barrel, cylinder head and the fan casing, which is integral with the oil tank, are made of aluminium die castings.

Finally, there was at the stand of Triumph Werke Nürnberg A.G. a rather remarkable engine which, though not a diesel engine in the strict sense, has a low fuel consumption of 0·440 lb per horsepower hour, and the remarkable specific output of ca. 24 h.p. per litre. The 534 c.c. air-cooled, two-stroke engine, type "LT 85," of 85mm bore and 94mm stroke, develops 12 h.p. at 3000 r.p.m., and, in its general layout, as well as in its constructional details, is hardly distinguishable from an orthodox crankcase-compression, loop-scavenged engine. It has a compression ratio of 11 : 1 and, therefore, relies for the safe ignition of the direct-injected fuel on the restriction of the heat flow from the thick-wall finned aluminium cylinder head. As this temperature is insufficient for starting from cold, the engine is run on petrol until the normal operating temperature has been reached. For this purpose a small petrol carburetter and ignition equipment, comprising a sparking plug in the cylinder head, a coil and a contact breaker, have been provided. The armature of the dynamo is located inside the flywheel fan, and the injection pump and the lubricator are mounted at the same end of the engine and driven from an extension of the crankshaft. The advantages claimed for this particular "semi-diesel" engine are that, in spite of the comparatively high brake mean effective pressure of ca. 60 lb per square inch, the peak pressure does not exceed 750 lb per square inch, so that the bearing loads and the stresses on the running gear can be kept low. This explains the light weight of the engine, amounting to 155 lb, equivalent to a unit weight at continuous rating of 13 lb per horsepower.

(To be continued)

AIR FILTER DEMONSTRATION.—An exhibition of its dust filter equipment is being held by Air Control Installations, Ltd., of Ruislip, at the Imperial Hotel, Temple Street, Birmingham, on June 1st and 2nd next. During this exhibition a film dealing with the design and operation of the firm's new "Dusgard" will be shown.

Rapid Starting Technique for Power Stations

INSTITUTION OF MECHANICAL ENGINEERS

A GENERAL meeting of the Institution was held in London, arranged in conjunction with the Steam Group, on Friday, 14th May, 1954, at 5.30 p.m. The following paper was presented and discussed :—

RAPID STARTING TECHNIQUE: SOME SIGNIFICANT TESTS AT POOLE POWER STATION

By J. S. HALL, B.Sc. Tech. (A.M.I.Mech.E.), and A. F. BRITTIN, B.Sc.

SUMMARY

It is believed that two important conclusions emerge from these starting tests. First, that with the unit arrangement, it is practicable to control boiler outlet steam temperature throughout the starting and loading periods, over a sufficient range to maintain optimum conditions at the turbine. This flexibility enables the starting behaviour of the turbine to be studied, and the optimum conditions established. Secondly, that optimum turbine starting conditions depend on steam temperature control, and, where this is available and understood, a starting technique can be evolved which ensures reliable and rapid starting. In the tests reported, the aim was reliability rather than speed, but the reliability was obtained with greatly increased speed of starting, compared with tests not having the benefit of temperature control.

A further conclusion is that cooling rates of piping need not be so much in excess of those of the turbine as to require special measures for heating the piping. Neither from consideration of the piping, or of the boiler characteristic, is steam dumping required in order to avoid excessive initial cooling of the turbine.

The two valuable features of the boiler characteristic are (1) the provision of superheated steam within a few minutes of lighting, and (2) the control of steam temperature as required throughout starting and loading.

DISCUSSION

Mr. W. Wilde : The present night load of the British Electricity Authority amounts to 5500MW and the day load, assuming that there is no load shedding, is about 16,500MW, so that the Authority is faced with the problem of starting 11,000MW of plant once or more every day of the year. The load factor on the national system is about 44 per cent—lower in some areas—compared with the load factors in the United States of over 60 per cent, so that our starting and stopping programme is relatively 33⅓ per cent more acute than that of our friends across the water. In the past, two-shift and single-shift operation has in the main been carried by low-temperature steam plant, but, with the rapid expansion of the construction programme, this duty will progressively pass to higher temperature plants.

Early experiences in the starting of high-temperature machines—bending of shafts, vibration and blade fouling, for example—made it imperative to exercise caution in the starting of these machines, and caution was not conducive to rapid starting. It is true to say that only the development of barring gear and, particularly in the last few years, the development of instruments to give the operating engineer information about expansion, eccentricity, vibration, the temperature of the machine and the temperature of boiler metals, has made it possible to carry out these and similar tests.

The authors repeatedly emphasise the need for control of steam temperature and they refer on page 1 to the outstandingly favourable conditions in this respect for rapid starting at Poole, particularly the fact that the boiler was able to produce steam at the temperature desired for the turbine within a few minutes of lighting up. There are, I suppose, at least half a dozen well-known and approved methods of controlling steam temperature, and at Poole two or possibly three of those were available—desuperheating, and burner tilting controls provided, &c.—but this is unlikely to be the case at present with many existing boiler designs.

On this installation, the authors seem to have been concerned to keep the steam temperature down on one or two occasions. I would express the view that on many boilers the problem will be to provide control to enable the steam temperature to be kept up or raised after a short period of shut-down. Nevertheless, the tests demonstrate that the temperature of the steam can be kept up at low steam flow without causing excess superheater temperatures. The authors describe at some length the boiler drainage arrangements. I should like to put a question to them : do they infer from this that the effect of drainage on the control of superheater metal temperatures is of little importance ?

It seems to me that it is a weakness in the paper that the condition of starting from temperatures of 250 deg. or below is not recorded fully, for this is an important condition of starting on the B.E.A. system on many occasions. Every Monday morning, many machines have to be started up after perhaps, forty, fifty or fifty-five hours shut-down. I should be glad if we could have information on the tests which were carried out under those conditions. The cooling of the metal temperature after steam admission, referred to by the authors, is a feature of all such tests, and I do not think it is ascribable to a cool section of the pipe. No significant reference is made to the control of gland steam and of gland steam temperature. It seems to me that this is a very important question.

Mr. W. W. Campbell : The effect of what we have been listening to is this : in point of fact, one of those boilers will do about 36MW even with its present rating, and we are dealing, I suppose, with what is basically a 40MW turbine, with 50MW overload rating. In fact, the choice of two boilers isolated to one turbine, each boiler being almost man enough to do the whole turbine, is not evidence of the most representative way of operation. It means that in the early stages of the operation the duty shared by the two boilers is not very like the duty which would be demanded of one boiler in a strictly unit system or of each of two boilers in a strictly two-to-one arrangement.

I do not suggest that this invalidates the authors' conclusions at all. I think the fact that they succeeded in achieving the starting times which they report with that arrangement is an indication that they have dealt with the problem in probably the more pessimistic case, but the fact that in the earlier stages most of the steam comes out of one boiler while the other comes in somewhat later may make things rather easier in the earlier stages.

By and large, the results seem to confirm that these machines can be started up quite rapidly, certainly for a limited number of times, without causing excessive vibration of the turbine or excessive metal temperatures of the superheater. That can be taken as

demonstrated. To what extent the paper has proved that, therefore, the turbines and other turbines of the same kind can go on being treated in this way regularly, without any ill-effects resulting, I am not quite sure. I do not think we can say until some time has elapsed.

There are certain matters which I do not think the tests have quite cleared up, for example, the boiler drum stresses resulting from the rate of pressure rise in the drum. I do not think there were any measurements of the drum stresses or differentials through the thickness of the metals or across the drum, and I should like to know whether this is because they thought it was of no consequence or because of some practical reason. In the turbine itself, I imagine that differential stresses due to temperature gradients across, for example, the horizontal flange, might be significant, in the sense that differential temperatures on rapid starting are bound to cause differential stresses which might be a bad thing if repeated for a long time. That seems to be a factor which remains in some doubt.

Nor is there any attempt to assess what is the total fuel consumed in the total process of starting up. I think that is a matter which should be more often assessed in tests of this kind. Obviously it is difficult to measure fuel accurately, but I think that in comparing one set of tests here with another set there it would be useful if there could be some estimate of the total fuel required to bring the machine up to speed and on to load; similarly, with the steam consumed.

On the boiler characteristics themselves, the thing which surprised me a little was that the superheater metal temperature was a maximum on the primary outlet. It was higher there than on the secondary inlet. How much desuperheating was being done in some of the tests? In some there was not very much. They were trying to keep temperatures up rather than down in some cases. In that case the temperature in the secondary inlet would be as high as in the primary outlet. Gas temperature would be higher. I should have thought that the lower temperature secondary inlet required some explanation.

Mr. Brittin must have accumulated for himself a vast amount of very useful information from the sixteen thermocouples stretched in a row across the superheater, both primary and secondary, and it must have thrown a good deal of light on this question of starting up fairly large boilers. I wonder whether it would be possible for any of the information to be disclosed, together with the difference between the primary and the secondary average temperatures.

Mr. G. R. Peterson: I think this paper has been presented at a very appropriate time because the question of quick starting is actively engaging the interest of the British Electricity Authority at the moment. They have set up a working party to investigate the whole subject.

From the point of view of the operator, there are three objectives in what is described as quick starting—first, safe starting; secondly, to achieve the minimum rate of loading which is necessary to meet the system requirements, and, thirdly, to try to achieve a more rapid rate of loading which will effect economies. First, the question of safe starting. The investigation being made into quick starting will undoubtedly enable us to know more about what goes on during the start, and the more we know the safer starting is likely to be. This may be of even greater economic value than the quick start itself.

On the question of the minimum rate of loading, a certain minimum rate is required, as Mr. Wilde pointed out. The load varies a great deal from day to night, and at certain times on the B.E.A. system the rate of rise of load is 120MW a minute. On new plant coming into service, it should be possible to increase the load at the rate of about 2½ per cent MCR MW capacity per minute, and a figure of this order is mentioned in the paper. Unfortunately, the paper does not give very much information about the rate of loading, as distinct from the rate of starting, and I wish more information had been given. There is a reference on page 8, in connection with loading, to a rate of rise in the inlet-end-metal temperature of 850 deg. Fah. per hour, which, over the fourteen minutes concerned, appears to work out at a 200 deg. rise. This seems a pretty severe rate of rise, and I wonder whether the authors have any apprehensions about metal failure or fatigue arising from a rate of change of temperature as high as that.

Finally, there is the question of achieving a rate of starting quicker than the minimum needed by the system. This can effect savings in two ways, broadly. First, less plant need be kept on the fires during the time of pick-up and during the valley loads and more economical load dispatching is possible. Secondly, there is less heat and auxiliary consumption during the quicker start. It is difficult to estimate in terms of money what those are worth to the B.E.A. system, but probably it is some hundreds of thousands of pounds. At first hearing, that sounds a big figure, but if you relate it to all the turbines on the system it does not work out to so very much.

There are one or two detailed questions I should like to put on the methods described in the paper. The paper says that before these various quick starts were made the load was dropped over forty minutes. This seems rather a long period, and I should be interested to know whether the authors feel that a quicker start might have been achieved if this load drop had been rather more rapid. The objective, I should have thought, was to keep the turbines as hot as possible, and the quicker you drop the load the hotter they would be at the end. I wonder whether they have formed any opinion as to whether there is any practical limit to the rate at which the load can be dropped.

Mr. C. W. Pratt: As far as the boiler is concerned only one or two of the tests reported are a little quicker than the normal procedure of 120 deg. Fah. saturated steam temperature increase per hour. Moreover, the authors make no mention of the possibility of turbine loading—apart from raising the speed—at pressures below the normal operating boiler pressure. Surely commissioning at some lower pressure, particularly when starting from a week-end shut-down, as Mr. Campbell mentioned, could also facilitate the mating and allow greater flexibility of firing control of the boiler and loading of the turbine.

Apart from the care needed for the maintenance of satisfactory superheater tube metal temperatures, final steam temperature and turbine chest temperature differentials, consideration may also require to be given to drum metal temperature differentials, although at Poole this was probably unnecessary because the drum thickness was probably below 4in.

Mr. P. F. Carson: I do not propose to put any questions to the authors, but rather to draw attention to some of the features of which further examination will be necessary before emphatic conclusions can be drawn. Consideration of the technique to be adopted in operating large unit and range installations must cover the full operating cycle and not one particular aspect of the cycle, except as an influence affecting the overall problem. Where the problem is associated with a unit installation, then we suggest that test results can be valid only when undertaken with one boiler and one turbine, although we would agree that data suggesting the requirements of a quick-starting technique can be obtained from such tests as those carried out at Poole.

Over the past two years, the company with which I am associated has performed a series of tests with both "range" and "unit" installations of 30MW, 50MW and 60MW capacity and with steam conditions of 600 lb per square inch gauge, 850 deg. Fah., 900 lb per square inch gauge, 900 deg. Fah., and 1250 lb per square inch gauge, 975 deg. Fah., and has just completed a series of tests in conjunction with the British Electricity Authority at Fulham generating station. From the data obtained in all tests certain criteria have been established which govern both the speed of run up and the subsequent loading rates, and appreciation of these has established techniques where, after a five-hour shut-down, a 50MW turbine has been supporting full load thirty-three minutes after first admitting steam. After a shut-down of fifty hours, the overall timing has been increased to 100 minutes, the extension being confined to a reduced rate of load application. The run-up time in each instance was substantially the same, around twenty minutes. Overall timing was increased as a result of a reduced rate of load application. It has also been established under both systems that, following an instantaneous rejection of full load, the load can be reapplied immediately at a continuous rate of 6MW per minute and over, without any problem at all.

The factors which determine the operating technique and the overall timing are as follows. First, the mass and heat transfer relationship between turbine rotors and casings. In a three-cylinder machine with operating conditions of 900 lb per square inch gauge—900 deg. Fah. and above, the h.p. casing particularly is of necessity of greater mass relative to the rotor, and it follows that for an equal heat input, or reduction, the rotor expansion, or contraction, will be more rapid than that of the casing. In short, there is a time lag before equalising expansion values of the two components are reached. This time lag results in a differential expansion value between the two, which reduces or increases the axial running clearances between moving blades and fixed nozzles.

Secondly, the temperature of the casing and the rotor at the moment of start up: the temperature of both components is of equal importance, it being appreciated that, prior to admission of steam to the nozzles, the shaft gland sealing steam is applied before raising vacuum. From data obtained we are of the opinion that following a five hour shut down, when continuous barring is adopted, the temperature of the shaft at the glands is 75 deg. Fah., or less, lower than the casing temperature in the vicinity of the gland housings. It follows, therefore, that the gland steam temperature on starting should be conditioned to within 50 deg. of the latter temperature. Shaft eccentricity troubles are virtually never encountered during run-up under this practice, where conditioning gland steam temperature applies.

The third point is the temperature and mass heat flow of the steam relative to shaft

and casing metal temperatures during start-up, run-up and subsequent loading. The fourth point is the differential temperatures within the casing. Here we are of the opinion that the rate of temperature rise of the casing metal is unimportant providing that the differentials obtaining are kept to a minimum.

In a unit system, where one boiler supplies steam to one turbine, we have found in all cases following short periods of shut down that the variation in initial steam temperature has been such as to aggravate differential temperature gradients between the steam and the metal of the turbine casing and rotor.

[The speaker showed a number of slides illustrating these points.]

In all our tests we have found that all load should be removed in thirty minutes, corresponding to an unloading rate of 1·5MW to 2MW a minute, and the machine then shut down.

Mr. J. Eyers : There is one aspect of rapid starting technique, mentioned by Mr. Campbell, which I think should receive a little more attention. It is the possibility that the rapid starting technique may result in substantial differences in temperatures developing between the steam pipe material and that of the flanges which, for high pressure plants, must be of substantial design. Serious trouble has been experienced in the flanges of steam ranges working for comparatively short periods—in one case less than two years—in the 700 lb to 1000 lb per square inch range with steam temperatures from 700 deg. Fah. to 925 deg. Fah.

Mr. F. L. Donnison : I had hoped that more detailed information would have been published to give some indication of the problems which the design engineer has to face in order to provide flexibility so that the purchasers may in turn keep in proper perspective the unit size, steam cycle and operating requirements. For instance, attention is drawn to the need for controlling the steam rotor metal temperature differential if uneven heating of the rotor is to be avoided, with resultant vibration. I am quite sure that full account was also taken of the limitations imposed by differential expansion, thermal stressing of rotors, flanges, bolts, &c., and any information on this and on such aspects of design which the authors can supply would be most valuable.

It was of interest to note that the Poole units are equipped with flange heating facilities, to which the authors make only passing reference. Many modern sets are similarly equipped, but it does not seem to be the practice of the designer to provide the operator with any specific guidance as to its correct application. I should have thought that indiscriminate use of flange heating could cause serious overstressing. Barring speeds range at present from 2 to 25 r.p.m. Would there not be some merit in adopting a barring speed in the range 25–50 r.p.m. in order to promote more even distribution of the residual heat in the rotor and casings during the shut down period ?

Mr. J. H. R. Nixon : This paper and the discussion so far have been centred on the axial-flow turbine, but I feel that a discussion on rapid starting techniques cannot be complete without a reference to the radial-flow double-rotation type of steam turbine which has been developed in this country, based on the invention of the Swedish scientist, Ljungstrom. The unique construction of this machine by-passed most of the turbine problems which are mentioned in the paper and therefore provided a solution to the problem of rapid starting. In this turbine there is no shaft to be distorted, as steam expands radially through the relatively light blade construction. By the time it reaches the outer casing it is at exhaust temperature and therefore the casing is not subjected to so high a temperature. Therefore the two main causes of trouble in the shaft and the casing are avoided. From the time of admitting steam to the stop valve, any synchronisation on full load can be done in routine operations in fifteen to sixteen minutes, and a rate of loading has been achieved of 20 to 25 per cent CMR per minute.

Dr. R. J. Eldred : There are three things, as I see it, which should be considered—the raising of speed, the raising of load and the raising of temperature. These three are not necessarily dependent on one another, although they may influence one another. To a large extent they can be regarded as completely independent of one another.

I would ask whether anybody has any reason to believe that it is essential for a machine to be to full temperature before they start loading ? That is certainly not the case with American techniques, where the machine will be put on load in perhaps twenty minutes to half an hour at the most, and it may be three hours or more later before the machine reaches full temperature. The boiler and the turbine are being brought up in temperature together at a nice steady rate, which does not distress the metal at all. It seems to me that the true definition of quick starting is how soon from the time of lighting the fire is it to the time of getting full load or economic load or whatever is a significant load. What is that length of time, not what is the time to reach full temperature ?

Mr. O. S. Woods : The United States have been working on this problem for a long time—five to six years, I think—and they have done so much work that they now assert that the principle of quick starting is very simple. All you have to do is to arrange for the steam admitted to the turbine to be at temperature equal to, or slightly higher than, the temperature of the turbine steam chest. They are so sure of their method in America—and they have published a lot of work on it—that they are now concentrating on the effects on the boiler and how to handle the boiler plant. It is true that their original experiments were on topping machines and that they could see an immediate financial saving. It seems that the problem is how to control the temperature of the steam at very low steam flows, and the authors have shown how this was attained at Poole.

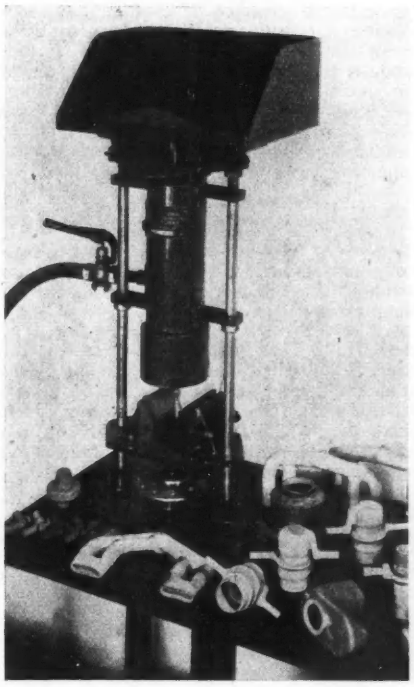
In the paper we read of a temperature increase rate of 850 deg. per hour, and unless we have exact knowledge about the castings, I think we shall run into trouble in directions other than bent shafts. It seems to me that we must be very cautious about the quick restoration of the turbine to service following an inadvertent trip-out. Quickly restarting it to service might have disastrous results for some high-temperature machines, because there seems evidence that there is a quick drop in steam temperature once you cease to pass it along the steam pipe. I view this purely as a practical man. Whether we take ten minutes or fifteen minutes to run a turbine to speed does not seem important in relation to a sixty or seventy-minute period from light up to full load. In fact, I suggest that we need fifteen minutes to walk round the set and have a look at it, checking its behaviour. It seems that now we want more information about the loading rates of machines. One application referred to at Poole was at 4MW a minute ; 2MW a minute is suggested. That does not seem very rapid to me.

Mr. J. S. Hall replied briefly to the discussion.

Bench Mounting Core Blowing Machine

An improved core blowing machine for bench mounting is now being made in two sizes, with sand chamber capacities of 12 lb and 36 lb respectively, by the Constructional Engineering Company, Ltd., Titan Works, Charles Henry Street, Birmingham, 12. The machines are generally similar in design and the smallest one can be seen in the photograph reproduced on this page, together with some typical examples of the cores it produces.

In this machine the sand hopper and sand chamber assemblies are supported from the base plate by two rigid steel columns. The clamping table for core boxes slides on the columns and is moved up to the chamber to adjust the vertical position of the boxes by a jacking screw. Once the core box height has been set a short movement of the handwheel through a lever is all that is required to raise and lower the table sufficiently for box filling and removing. The left-hand fixed member of the horizontal box clamp positions the core box in relation to the blowing hole in the sand chamber. The right-hand member effects box clamping by a simple lever-operated cam motion. This clamping unit has a limited movement to compensate for any unevenness in the core boxes.



Bench core blowing machine with 12 lb capacity sand chamber and examples of typical cores it is designed to produce

Large quickly interchangeable base plates in the sand chamber can be drilled at a number of points to match core box equipment and separate blow heads are not required with the machine. When using the machine the sand in the chamber is aerated before and during the blowing process and is carried into the core box in a continuous stream through the holes in the base plate.

The smaller of the two machines takes core boxes up to 7¼in high by 6¼in wide and 20in long, and the larger machine boxes up to 8¾in high by 8¼in wide and 24in long.

Projection Welding of Mild Steel.—The British Welding Research Association, 29, Park Street, London, W.1, has just published a new technical book, "Projection Welding of Mild Steel." Projection welding is a method of resistance welding in which current flow and heating during welding are localised by the form of the parts being welded rather than by the electrodes in contact with the work. The book has been compiled by a committee of the association. It covers all aspects of projection welding and makes recommendations with regard to plant, materials, types of projections and machine settings. The new publication is available from the association's offices at 3s. 6d. net.

Symposium on Concrete Quality and Mix Design

A SYMPOSIUM on mix design and the control of quality of concrete was held in London last week at the Empire Rooms in Tottenham Court Road. The symposium was organised by the Cement and Concrete Association ; it was held from May 11th to the 13th, during which time twenty-two papers were presented for discussion. Each paper treated a specific aspect of the general problem of the control of the quality of concrete. The various contributors were drawn from different sides of the civil engineering world, and included, for instance, contractors' engineers, research engineers, consulting engineers, and those responsible for the manufacture of precast products and ready-mixed concrete. Mix design for special purposes—for abrasion resistance, for example—was discussed in some of the papers. In the paragraphs below we print an abstract from the introductory address to the symposium, which was delivered by Dr. W. H. Glanville, Director of the Road Research Laboratory.

About thirty years ago when I first began to study the subject of this symposium at the Building Research Station, the foundations of our present knowledge had already been laid ; but they were in a primitive form, were little known, and their importance scarcely appreciated. The work had been done mainly in France, Germany and America ; Great Britain had contributed very little. Knowledge of the pioneer work of Feret, Fuller and Abrams had scarcely penetrated to the civil engineering departments of the Universities and was certainly quite unknown to the great majority of consulting engineers and contractors. Usually concrete proportions were arbitrarily chosen without prior testing of the materials and where tests were made they consisted of crudely made void tests, the principle being to add sufficient sand to fill up the voids in the stone without particular regard as to whether or not the sand would or would not be too big to fit into the gaps. Testing methods had not been standardised and control was virtually unknown. The usual practice was to add plenty of water to make sure that the moulds were filled with little effort in every corner, and the theory was seriously expounded that mixing concrete for too long turned it brown : if I dared to suggest proportioning by weight or the use of graded aggregates I was listened to with an air of amused tolerance which suggested that I had no appreciation of practical difficulties.

With the publication by the Lewis Institute, Chicago, of Abram's water/cement ratio law in a paper " The Design of Concrete Mixtures " a new era began. In principle Feret had forestalled him, but had not recorded the simple fact that for practical purposes with properly placed concrete the air voids could be ignored and that the ratio of water+air voids to cement could be simplified.

Of course, these were only the beginnings, and progress in knowledge and in the application of knowledge, which was very slow to begin with, has steadily speeded up as experience has shown that concrete can be made into a structural material of high and consistent quality and that to do so can save money, can save cement, and at the same time produce a better job. It is not that there is now no place for concrete of the garden path variety ; it still has its uses. There are still occasions when it may not pay to go to the trouble of careful mix design and quality control, but we now know more about when and where it pays to do so.

In recent years many of the larger contractors, having tasted of the succulent fruits of scientific mix design and quality control, have become ardent exponents and practitioners of the scientific method. A number of them have large and efficient laboratories—headed and staffed, so far as I can see, largely by officers drawn by one means or another from the Government research organisations. Some of you may, in fact, have noticed that on occasion it is the contractors who provide the driving force to improve the methods and specifications of the authorities responsible for preparing them. All this is to the good for the urge is for progress because it has proved profitable.

The papers to be presented on the subject of mix design show an interesting state of development of the subject. They show how the subject is broadening. No longer is the concern so much with the basic general principles—they are now reasonably well understood—but with mix design with special aggregates and with concrete for special purposes—lightweight concrete, prefabrication, high flexural strength, resistance to abrasion and to frost, and so on. The design of mixes for special purposes will emphasise the need for special developments in quality control.

In all structural materials complete uniformity of properties is unattainable. Uniformity depends on many things and is easier to obtain with some materials than with others. Steel, for example, is usually more uniform than concrete and concrete more uniform than stabilised soil. But however great or small, the variability and its magnitude should be known by the engineer so that he can design his structures with the least possible waste. This implies a statistical approach and leads also to questions of design philosophy. The statistical approach is now evident in the growing use in concrete work of the methods of quality control used to maintain standards with factory products. As with mix design, the part of the symposium dealing with quality control indicates a broadening of the field. In a number of papers it is considered in relation to structural design, to precast concrete compaction, roads, airfields, dams and ready-mixed concrete. To be acceptable a statistical approach must be based on adequate data under practical conditions, and it is clear that a growing volume of reliable test data is becoming available. Since the development of mix design and quality control procedures is necessarily based on test data, it is appropriate that the subject of testing concrete should be included in this symposium. It is particularly to be noted that the non-destructive testing of concrete will receive attention. The advances made in recent years in this field of concrete technology are likely to have important repercussions on the quality of construction work since the methods of test enable the actual concrete in a structure to be tested and its *in situ* quality assessed.

It may be useful to consider the manner in which future developments may take place. All those concerned with the production and use of concrete will recognise that there is room for much improvement. It is still not uncommon to see materials being batched by volume and old, worn-out and inefficient plant being used. Some of our contractors' organisations, especially the large ones, are fully conscious of the advantages accruing from good mix design and quality control, and it is to be hoped that their splendid example in applying the necessary techniques will spread to the whole of the construction industry. Perhaps the most important need at present is for skilled, continuous and detailed supervision of all the operations. Care and skill put into designs and specifications can be completely wasted by inferior workmanship and supervision on the job. The difference between good and bad workmanship and supervision may well be represented by the difference between an almost indefinite life and a life of only a few years. There is still room for further research and development. The statistical examination of the larger quantity of data now becoming available will indicate with increasing precision the relative importance of the control operations. There is a need for better meters to measure the amount of moisture in the aggregates, for improved methods of testing the workability of concrete in the field and for the development of quality control charts to facilitate field control. I imagine, also, that the manufacturers and producers of the constituent materials could help forward general progress by considering the way in which control measures or modified production techniques might help to produce more uniform ingredients of the concrete.

The scope and variety of the papers presented to this gathering show how much progress has been made in recent years and the numbers of those attending shows how keen the engineer of to-day is to make use of the latest findings of research and of the experience of his colleagues. The search for better testing methods, for better control methods, for higher and more consistent quality continues unabated.

100/175W Power Output Panel for A.C. Mains

A NEW power output panel has been designed by The General Electric Company, Ltd., for use in sound equipment installations in places such as railway stations, large industrial premises and radio relay where high-power amplification is required. It can be incorporated in high-quality relay systems to give an output of 100W under mainly class A conditions, or in industrial public address systems where it will provide 175W under moderate class AB2 drive. Up to twenty-four of these power output panels, operating in the 100W condition, can be connected to a driver panel to provide a maximum output of 2400W ; alternatively up to twelve panels, operating in the 175W condition, will provide a maximum output of 2100W. Such arrangements are particularly suitable in large installations with either pooled or multi-channel outputs, and also in installations where extensions to the original system may be needed in the future.

In its output stage the panel has two " Osram " DA100 valves operating in a push-pull circuit under alternative conditions, whereby an output of 100W is provided in class A or class AB1 operation and of 175W in moderate class AB2 operation. The input terminals are connected directly to the valve grids, which are tied to the chassis by appropriate resistors. The output transformer is provided with an electrostatic screen between the primary and secondary windings, the latter being divided into two balanced sections so that series or parallel connection is possible and a wide range of output voltages and impedance is obtained. The h.t. supply is provided by four bridge-connected, directly-heated vacuum-valve rectifiers, with choke input to the high-voltage paper dielectric reservoir condenser. The choke is fitted with a resistor/capacitor limiting network. The h.t. and l.t. supplies are provided by separate mains transformers with independent switching, to allow for standby running on heaters only, with instant operation facilities for remote control equipment if desired. A meter is provided, with an associated switching key, to indicate the cathode current of the two output valves either singly or together.

The equipment is fitted with a preset bias control for each valve, and mains l.t. and h.t. on/off switches with green and red indicator lamps respectively. The input for 100W output, mainly under class A conditions, is 260/290V r.m.s., and for 175W output with moderate class AB2 drive 375/420V r.m.s. The equipment operates from an a.c. power supply of 200V–250V at 50–100 c/s. Standby power consumption (l.t. only) is 86VA, while full running consumption is 567VA (at maximum output). The frequency response is maintained within ±2db throughout the range 50–10,000 c/s. With a 100W power output under class A conditions, total harmonic distortion is 3 per cent. With a 175W power output and moderate class AB2 drive the total harmonic distortion is 6 per cent.

The complete equipment, the BCS 1238, weighs 96 lb and is mounted on a panel measuring 15¾in high by 19in wide. The two output valves are mounted on the front of the panel, where they are readily accessible and heat is quickly dissipated.

American "Mariner" Class Cargo Ships

(By Our American Correspondent)

With the approaching completion of the last of thirty-five cargo vessels of the "Mariner" class, the U.S. Maritime Administration has provided the American merchant navy with a nucleus of post-war, high-speed general cargo ships. The design and construction of these ships represent the best current practice in this field in the United States. Seven American yards were awarded contracts to build five each of these freighters, and the present article deals in particular with the steamship "Old Colony Mariner," which was constructed by the Bethlehem Steel Company at its yard in Quincy, Massachusetts.

REALISING the poor condition of the American merchant navy when military action began in Korea in the summer of 1950, the U.S. Maritime Administration decided to develop a new design of cargo ship to be constructed in considerable numbers. The design of these "Mariner" class ships stressed the importance of (*a*) their being economically sound for operation by private owners; (*b*) their speed and manœuvrability being suitable for military purposes; (*c*) their ready convertibility from military transport or supply applications to a variety of civil uses, and (*d*) their being equipped with efficient cargo handling gear to minimise their required time in port. As a result of competitive bidding, the Shipbuilding Division of the Bethlehem Steel Company received the contract for the development of construction drawings and specifications for these ships in October, 1950. The plans were completed in January, 1951, and, in the following month, contracts were awarded to five yards for the construction of five ships each. In June and August, 1951, two additional yards received orders for five ships each, bringing to thirty-five the total number of "Mariner" class ships to be built at the yards shown in Table I.

TABLE I—*Builders of "Mariner" Class Ships*

Bethlehem Steel Company	Quincy Yard	Massachusetts
Bethlehem Steel Company	Sparrows Point Yard	Maryland
Bethlehem Pacific Coast Steel Corporation	San Francisco Yard	California
Newport News Shipbuilding and Drydock Company	Newport News Yard	Virginia
Sun Shipbuilding and Drydock Company	Chester Yard	Pennsylvania
New York Shipbuilding Corporation	Camden Yard	New Jersey
Ingalls Shipbuilding Corporation	Pascagoula Yard ...	Mississippi

Although all thirty-five ships were built from the same drawings and specifications, the Maritime Administration recognised that exact duplication of all structural details, machinery and equipment would be neither wise nor practical. Minor variations in structural detail have, therefore, been permitted; and, to obtain a better distribution of work and earlier deliveries of equipment, various units have been built by different manufacturers, all working to the same specifications, performance guarantees and weight, strength and space limitations. Certain principal dimensions and general characteristics of the "Mariner" ships are given in Table II.

The satisfactory performance of the "Mariner" ships was demonstrated some time ago, when the "Old Colony Mariner" (Fig. 1) underwent standardisation trials at two displacements. She was run over the Provincetown measured mile at 11,433 tons with the ship trimmed 12·12ft by the stern, and over the Rockland measured mile at 16,428 tons with 3·26ft by the stern. The results of these trials, corrected for wind and current, are given in the accompanying graph, Fig. 3.

TABLE II—*Dimensions and Characteristics*

Length overall	563ft 7½in
Length between perpendiculars	528ft 6in
Beam, maximum, moulded	76ft
Depth moulded, to main deck	44ft 6in
Depth moulded to second deck	35ft 6in
Load line draught (to bottom of keel)	29ft 10in
Displacement (load-line draught), tons	21,093
Deadweight (load-line draught), tons	13,418
Shaft horsepower, maximum	19,250
Shaft horsepower, normal	17,500
Speed, sustained at 29ft 10in draught, knots ...	20
Speed, trial at 29ft 10in draught, knots	21·1
Speed, sustained at 31ft 7in draught, knots	19·8
Speed, trial at 31ft 7in draught, knots	20·9
Complement:	
Passengers	12
Crew	58

General Arrangement

The hulls of the "Mariner" class ships have two complete decks as well as one partial deck forward and two partial decks aft. A continuous double bottom extends from the forepeak bulkhead nearly to the afterpeak bulkhead. The propelling machinery and accommodations are amidships. A rather long forecastle extends from the stem over the full

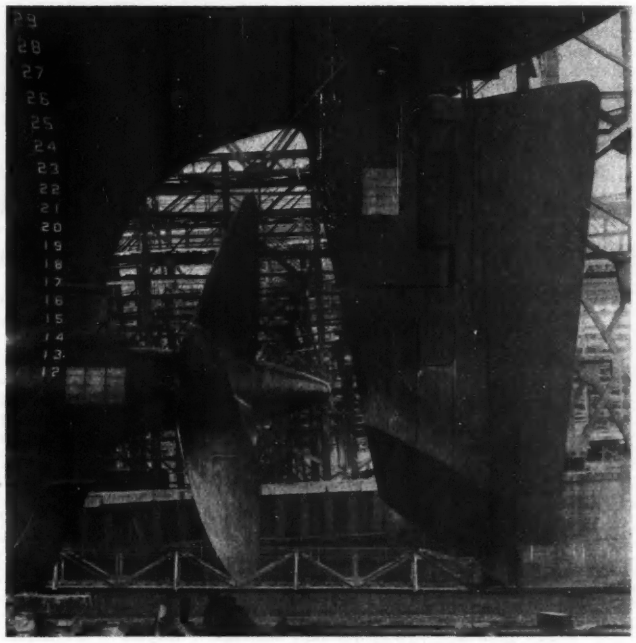


Fig. 2—Rudder and propeller

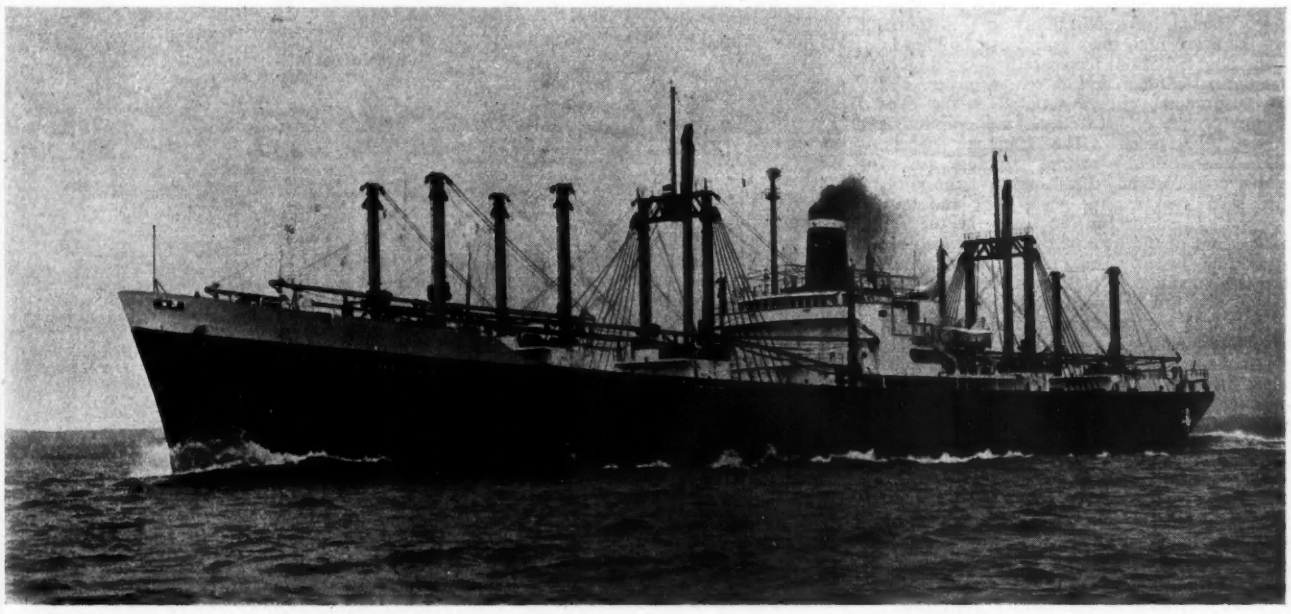


Fig. 1—"Mariner" class steamship "Old Colony Mariner"

length of the forward cargo hold. There are seven holds for general cargo, four being situated forward of the machinery space and three aft. Deep tanks fitted to carry fuel oil are provided in the lower parts of No. 1, No. 6 and No. 7 holds. The double bottom is arranged to carry fuel oil or water ballast ; the fore peak and aft peak are for water ballast only ; while fuel oil settling tanks and fresh water tanks are placed at the sides of the machinery space. A superstructure amidships provides accommodation for twelve passengers and the crew of fifty-eight officers and men, together with space for the wheel-house and for navigating and wireless equipment on four decks.

On the main deck within the house there are twenty-two cabins, for thirty-nine of the ships' crew, arranged so as to make each an " outside " room. Six double cabins for twelve passengers, are situated on the upper deck, next above the main deck ; also the passengers' lounge and ten single cabins for the purser, the chief steward, six officers and two cadets. A bulkhead at one end of the machinery casing separates the passenger spaces from the officers' accommodation. On the next deck, named the cabin deck, are staterooms and offices for the captain and the chief engineer, six single cabins for four deck officers and two assistant engineers, and a dining-

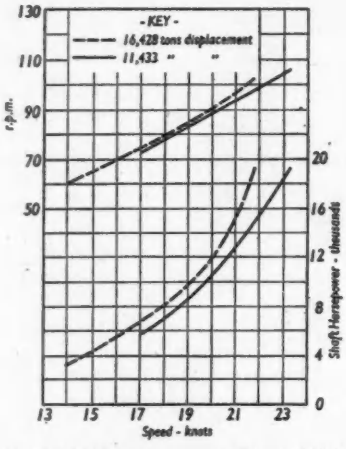


Fig. 3—Performance curves of S.S. " Old Colony Mariner "

room for officers and passengers, together with a pantry. The bridge deck accommodates the wheel-house and the navigating and wireless equipment.

The scantlings of the " Mariner " class ships are suitable for a draught of 31ft 6in, although, as shelter deck vessels, the summer freeboard draught is only 29ft 10in. The ships are transversely framed, have solid floors on each frame, and there are nine main transverse bulkheads. In the double bottom there are four continuous longitudinal girders and a centre girder, and the longitudinal girders situated at the sides of the hatches on each deck, are continuous through the holds. The framing, girders, brackets and double-bottom structure are of welded construction. Flush-welded butt joints have been used for the shell, deck and tank top plating, except for the seams at the top and bottom of the turn of the bilge, which are lapped and riveted. There is also one strapped, riveted butt strake of plating in the main deck at each side, just outboard of the hatches. The gunwale bars are riveted. The main bulkheads, machinery seatings, deck houses and other principal structural parts are generally of welded construction. The construction of these ships has been carried out under the survey of the American Bureau of Shipping and conforms with the A.I.E.-A.M.S.-R.M.C. classification regulations of that body.

An interesting design was developed for the rudder and rudder supporting members of the " Mariner " class ships (Fig. 2). Each of these ships has a semi-spade rudder, supported at a little below the middle of its height by a faired cast steel cantilever post. The lower end of the rudder stock is tapered and keyed ; it projects through a matching opening in the top member of the rudder frame and is held

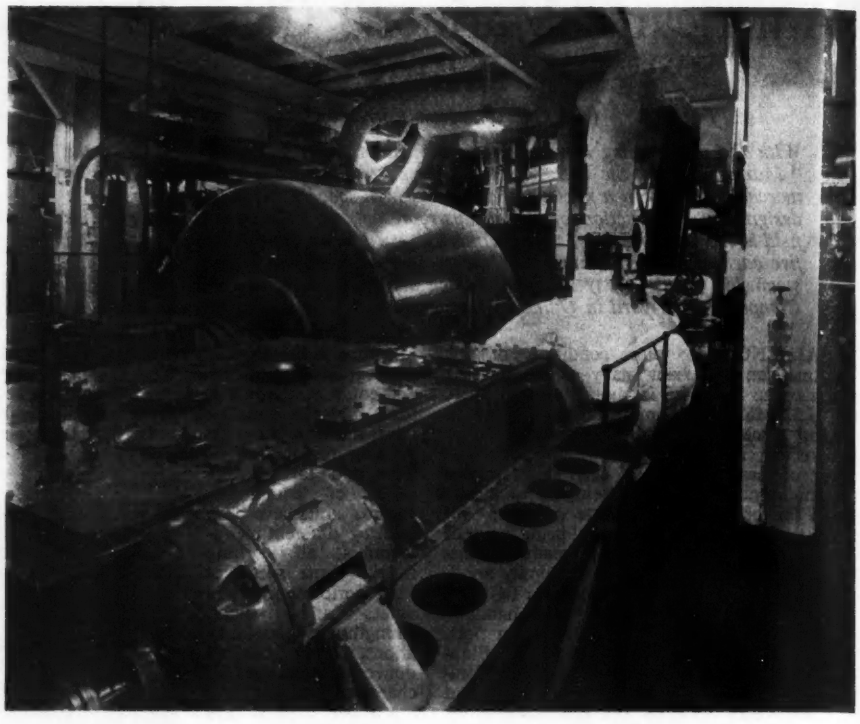


Fig. 4—Cross-compound turbines and double-reduction gearing

firmly seated in this opening by a screw thread at the bottom of the stock and a locked nut. The upper bearing is on the rudder stock and is carried in a second steel casting which forms the trunk around the stock. These two castings are bolted securely and welded to each other and are connected by welding to the flat at the 32ft level, the shell plating and all other adjacent hull structure. Another bearing for the rudder stock and the bearing which carries the weight of the rudder and stock are situated at the steering gear flat. Above the rudder support castings, the stern frame is built of shaped steel plates ; below, it is formed by three additional cast steel members welded together.

This rudder and stern frame design was adopted in order to provide the greatest possible clearance around the propeller. As these ships require about 20,000 h.p. to be delivered by a single propeller, an unusually large clearance was considered necessary in order to avoid excessive vibration. With the conventional design of single-screw stern frame, it would have been difficult, if not impossible, to provide the clearance desired. With the present arrangement it was possible to move the propeller downward nearly 2ft and this gain was divided between increasing the clearance above the propeller and improving the shape of the hull.

The " Mariner " class ships are said to

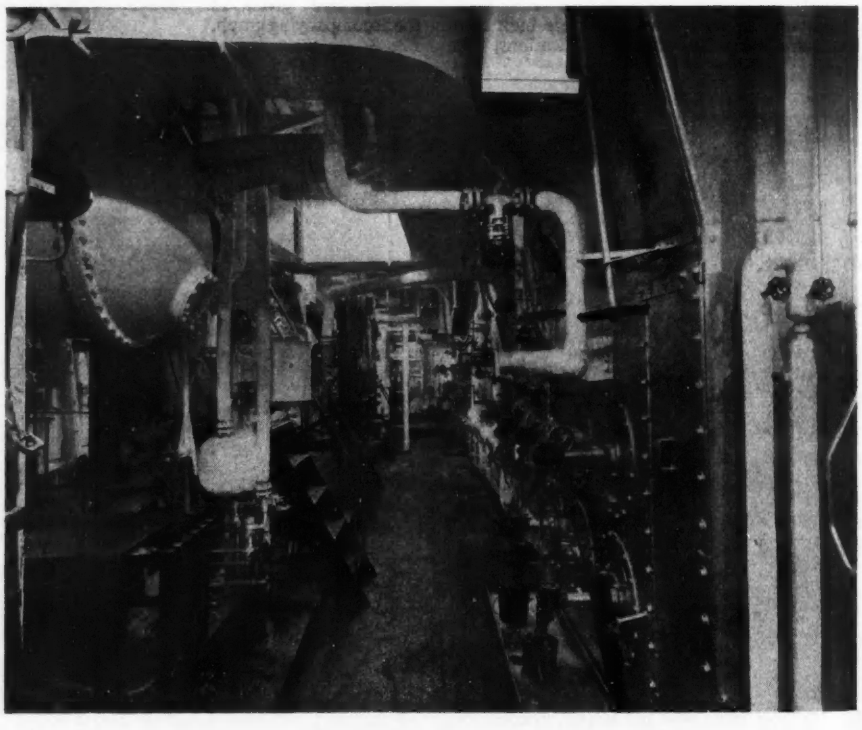


Fig. 5—Boiler-room with two 600 lb per square inch water-tube boilers

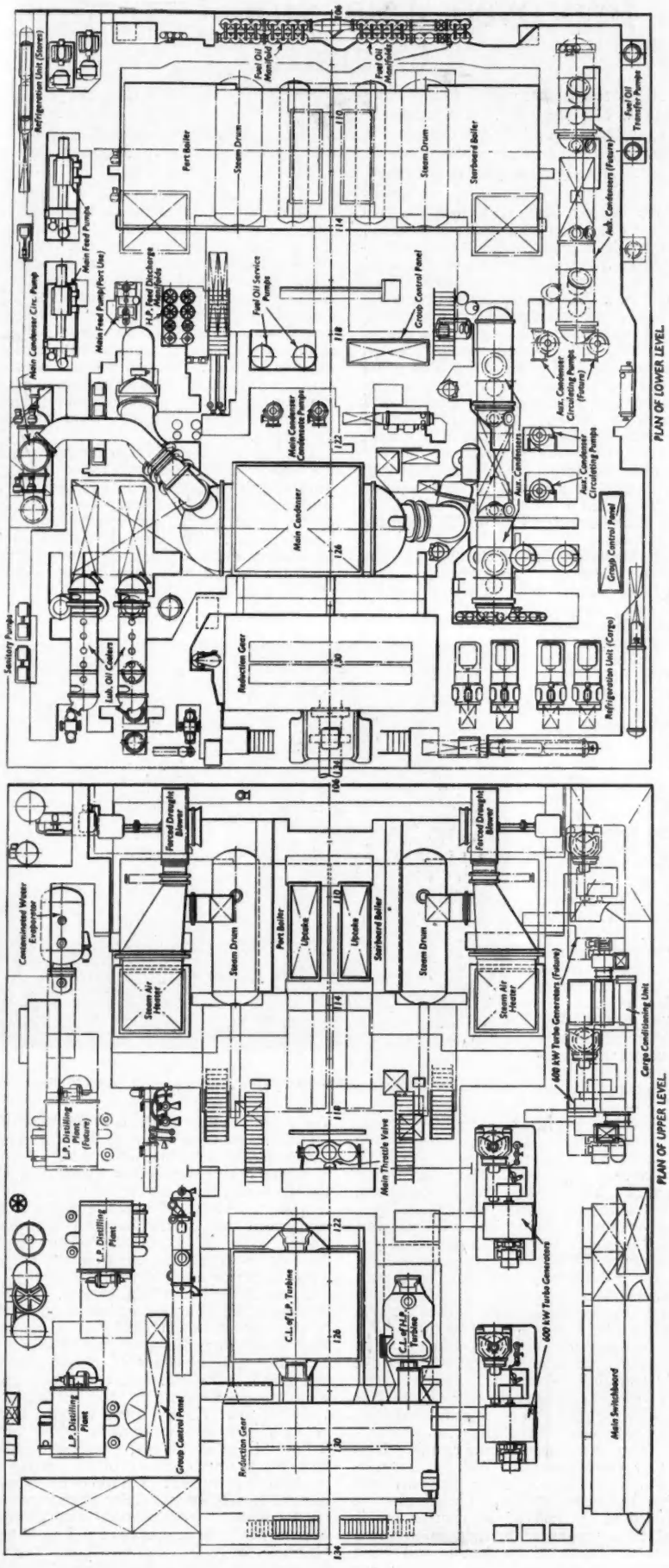


Fig. 6—Arrangement of machinery rooms in "Mariner" class ships

be the first American general cargo ships to be equipped almost entirely with quick-acting, folding steel hatch covers assembled with hinged sections. When opened the hatch cover sections fold compactly and lock in a vertical position at the ends of their respective hatches. All hatch covers on the forecastle, main, and second decks close watertight without the use of tarpaulins ; the weather deck hatches have 30in coamings. The cargo handling equipment consists of seven pairs of kingposts. Two pairs of stayed kingposts are connected transversely by trusses which carry the two topmasts and support the hoisting and topping forces of the 60-ton derricks. There are two 60-ton derricks, each 70ft long, mounted on pedestals at the centre-line of the ship in positions to serve No. 4 and No. 6 holds. There are ten 10-ton and fourteen 5-ton derricks which are mounted in pairs, port and starboard, on the kingposts. This arrangement makes it possible for each of five hatches to be worked by two 10-ton and two 5-ton derricks simultaneously. No. 1 and No. 7 holds are each served by one pair of 5-ton derricks.

All topping lifts for the 5-ton and 10-ton derricks are secured permanently on topping winches mounted on the kingposts. There are twenty-four of these winches, each driven through worm gearing by a 440V, three-phase a.c. squirrel-cage induction motor. Furthermore, there are twenty-four single-drum cargo winches, each driven through double-reduction gearing by a 230V d.c. motor. Each winch is equipped with solenoid brakes and a pedal-operated drum brake. The cargo winch and topping lift motor controls are grouped at operating stations giving each operator a clear view into the hatch and over the side. The specified cargo hook hoisting speeds vary from 287ft per minute with 1¼-ton loads, single purchase, to 118ft per minute with 5-ton loads, double purchase, and 58ft per minute with 10-ton loads and a four-part purchase.

Propelling Machinery

The general arrangement of the machinery spaces is shown in the line drawing (Fig. 6) and in designing the propelling machinery for these ships, a single-screw installation was selected due to its greater efficiency, simplicity of operation and its smaller number of working parts in comparison with a twin-screw installation. The main propulsion unit of each "Mariner" ship consists of a cross-compound turbine (Fig. 4), which drives a four-bladed, solid manganese bronze propeller of 22ft diameter and 22ft 10in pitch through double-reduction gearing. The turbines have a normal rating of 17,500 s.h.p. at 102 r.p.m. of the propeller and a maximum rating for continuous operation of 19,250 s.h.p. The turbines designed and manufactured by the Bethlehem Steel Company, which were used also in the other nine vessels built at the Quincy and Sparrows Point yards, each have a high-pressure turbine with one stage of impulse blading followed by seven expansions of reaction blading, totalling twenty moving rows. Bleeder connections are provided on the high pressure turbine at the entrance to the fourth expansion and at the cross-over between the high and low pressure turbines. The low pressure turbine is a single-flow unit with twenty moving rows of reaction blading and a bleeder connection is provided at the entrance to the fourteenth expansion of this turbine. Also incorporated in the low pressure turbine casing are the two stages of impulse blading of the astern turbine, which is capable of operating astern continuously at approximately 6100 s.h.p. with a condenser vacuum of 27·5in Hg. The gearing is of double-reduction, double-helical design and the reduction ratios are 4233 to 102 for the high pressure turbine and 2201 to 102 for the low pressure turbine. The propeller thrust bearing is a Kingsbury 45in, eight-shoe, self-aligning, equalising bearing, situated just aft of the reduction gear casing.

Steam is supplied by two two-drum, bent-tube water-tube boilers (Fig. 5) fitted with superheaters, desuperheaters, economisers, steam soot blowers, automatic combustion control, superheat control, automatic two-element feed regulators and atomising fuel oil burners. The

boilers are designed to maintain a pressure of 600 lb per square inch gauge at the superheater outlet, with a temperature not in excess of 875 deg. Fah. at normal and maximum power ratings. Each boiler evaporates 64,000 lb per hour at normal power and steam normally reaches the turbine throttle valves at 585 lb per square inch gauge and 855 deg. Fah. Each boiler has a generating and waterwall surface of 8040 square feet, a superheater surface of 1565 square feet, and an economiser surface of 4190 square feet, while the furnace volume is 1315 cubic feet. The superheater is of the two-pass, integral convection design and is situated in the boiler bank. The superheater tubes are rolled into the headers and are fitted with forged return bends, and an aluminium fin-tube economiser is placed in the gas uptake of each boiler. Two submerged desuperheaters are situated below the water level in the steam drum, one is used to supply auxiliary steam at reduced temperature ; the other is for use with the superheater temperature limiting control. This limiting control provides a manually controllable by-pass between the two passes of the superheater, thus furnishing a means for controlling the amount of superheat. Fifteen of the thirty-five boilers ordered for these vessels were supplied by Combustion Engineering, Incorporated, ten by the Foster Wheeler Corporation and ten by the Babcock and Wilcox Company.

Exhaust steam from the main turbines is condensed in a horizontal, single-pass condenser with 16,000 square feet of cooling surface which maintains a vacuum of 28·50in Hg when supplied by scoop injection with 33,000 gallons per minute of sea-water at 75 deg. Fah. For port use, astern operation and low speeds ahead, a motor-driven, 18,000 gallons per minute propeller circulating pump is provided. Two stages of feed heating are employed in conjunction with air heaters, thus providing a simple and effective regenerative feed system. There are two main condensate pumps, each having sufficient capacity to handle the condensate when the ship is running at maximum power. These vertical, two-stage, centrifugal pumps are each able to deliver 325 gallons per minute against a total discharge head of 135ft. The discharge from the main condensate pumps passes through the inter and after condensers of the main air ejectors into the low pressure feed heater. This is a horizontal, straight-tube unit having feed heating, gland leak-off condensing and drain cooling sections combined within a single shell. The feed heater section will heat 109,000 lb of condensate per hour from 110 deg. Fah. to 175 deg. Fah. when supplied with 7500 lb per hour of steam at a pressure of 9 lb per square inch absolute. The gland leak-off section will handle up to 1000 lb per hour of steam leakage from the main propulsion and generator turbine glands, the deaerator vent and flash vapour from the drain collecting tank. From the low pressure feed heater, the condensate enters a direct-contact, deaerating feed water heater which raises the feed water temperature to 250 deg. Fah. The condensate pump which serves the auxiliary condenser discharges through the auxiliary air ejector inter and after condenser into the main condensate line just before the low pressure feed heater. The two main feed pumps are turbine-driven, using desuperheated steam from the main boiler and exhausting at a back pressure of 15 lb per square inch into the auxiliary exhaust system. These five-stage, horizontal, centrifugal pumps are each designed to deliver 450 gallons per minute against a total head of 2000ft at 4650 r.p.m. One turbine-driven, single-stage, centrifugal feed pump, having a capacity of 150 gallons per minute against a 1770ft head, is installed for use while the ship is in port.

Each of the " Mariner " ships has two 600kW, 450V, three phase, 60 cycle turbine-driven generators, either one of which is able to supply all normal electrical requirements. The power distribution from the main switchboard in the engine-room is generally through three phase, three wire, 450V lines, and most of the electrically-driven auxiliary and deck machinery operates on this current. A 75kW, 450V, three phase, diesel-driven generator and an emergency switchboard are situated on the main deck amidships.

Improved Television Camera Channel

A new television camera channel has been developed by Marconi's Wireless Telegraph Company, Ltd. It is designed to incorporate the English Electric Valve Company's 4½in " Image Orthicon " tube. The same basic equipment is used either for studio or for mobile work and the electronic viewfinder is designed to be set at any angle irrespective of camera elevation.

THE new Marconi Mark III television camera channel which has been designed to incorporate the 4½in English Electric " Image Orthicon " pick-up tube was demonstrated recently at the Marconi Research Laboratories, Great Baddow, Essex. The camera channel comprises the camera itself, together with a quantity of associated equipment, including camera control chassis, picture and waveform monitor chassis, focus supply unit and either a regulated power supply chassis for studio use or a mobile regulated supply unit for outside broadcasting. It is fitted with an electronic viewfinder of special design which enables it to be set at any angle independently of the camera elevation.

The equipment forming a complete television camera channel is available in various forms suitable for studio or mobile use on 405, 525 or 625-line systems, with 50 c/s or 60 c/s mains power supplies.

In both studio and mobile channels the same camera is employed. The camera control chassis and picture and waveform monitor chassis are mounted together to form a single camera control and preview monitor position and fitted in a studio console housing or mobile case. The equipment is built in three main parts—the camera proper, viewfinder and lens turret (as illustrated) —and for transport purposes they can be carried separately. Carrying cases are provided for the turret and lenses, and the camera is designed to fit on a standard shock absorber mounting. Assembly is simply carried out and quick release devices afford rapid removal of individual units.

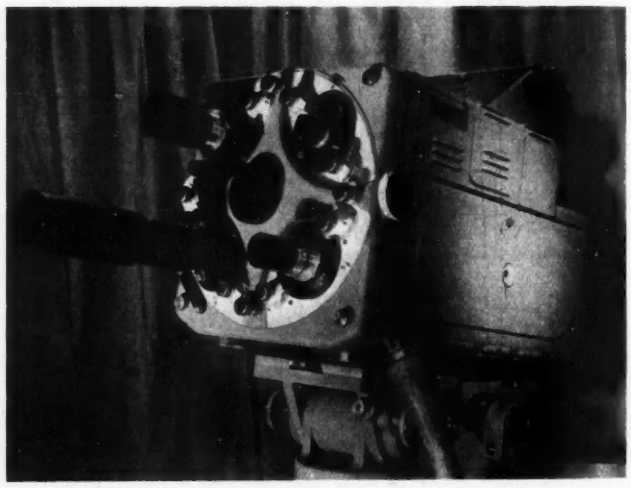
The "Image Orthicon" tube illustrated (on page 763) together with its deflection and focus coils and associated vision amplifier — which are mounted on the yoke carriage assembly—form one compartment at the left-hand side (viewed from the front of the camera). The vision amplifier is built on to a plug-in chassis. The yoke carriage runs on ball bearings and may be locked in position (as may be required when zoom lenses are used or during transit). The deflection coils may be " rocked " ±45 deg. to give tilted pictures—a useful facility in some productions.

The tube is fitted from the front of the camera by a simple plug-in process and side contact bases are used to afford greater reliability. No blower is needed in this camera, since the focus coils are designed for low temperature operation and electronic temperature control of the yoke heater winding is incorporated.

In the centre compartment there is the lens turret rotating mechanism which can, if required, be motorised so that lens changing can be controlled from the camera control unit. This latter may be required for entirely remotely-controlled operation including pan and tilt facilities. For manual use a turret rotating handle is provided at the rear of the camera and is coupled to a non-linear gearbox so arranged that one revolution of the handle will bring another lens into position. This operation, we are informed, takes approximately one second.

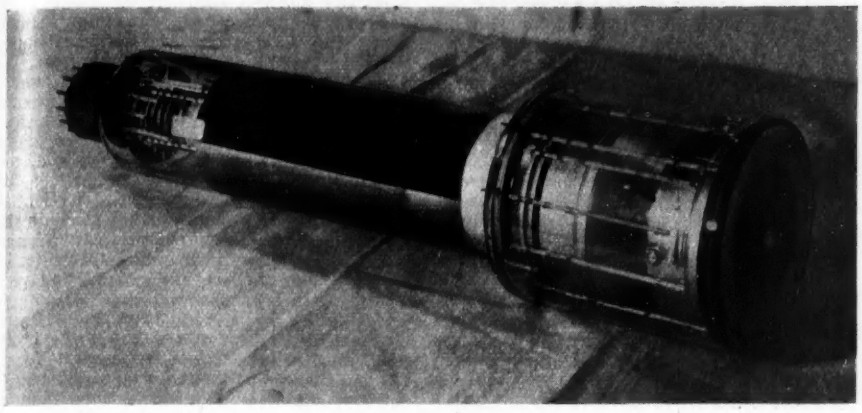
On the other side of the camera three units plug into a main chassis, which is itself hinged, giving ready access for servicing. The sub-assemblies comprise the line scan generator, e.h.t. generator and scan protection circuits, blanking mixer, focus modulator, and vision amplifier output stages. High efficiency scanning systems are used, and the need for linearity controls is eliminated by the careful application of negative feedback. A neon indicator shows the correct operation of the scan protection circuits. Pre-set controls, fuses, main cable plug and mains transformer are also accessible from this side of the camera.

The talk-back chassis forms the rear panel of the camera which carries jacks for connecting the cameraman's headset and microphone and two additional headsets and headphones. A microphone on/off switch and volume control are also provided. The controls on the camera are located behind a hinged door, which is open when the camera is in operation and carries a clip for holding a script and a small note tablet.



Television camera suitable for 4½in or 3in " Image Orthicon " pick-up tube

The turret rotating handle is at the back of the camera below these controls, and the panning handle may be fitted into either side. Focusing is carried out by means of a handle located on the right-hand side (relative to operator) of the camera, movement of which operates a lever mechanism that causes the yoke assembly to travel. One version of the camera permits focusing to be carried out from the left side. Two cue lamps are mounted, one at the front and one at the rear of the camera. Provision is made for fitting a panning handle on the body of the camera, which facility is of particular value when heavy lenses or zoom lenses are in use. The camera has a " V " block at the base and this is adjustable fore and aft to give a proper balance of weight with different lens combinations. There are two carrying handles in each side of the camera. The camera is finished outside in light grey rivelled enamel with black or chromium plated fittings and inside in white enamel. The top of the camera is recessed to take the viewfinder which is mounted on a counterpoise suspension, thus permitting extreme flexibility in operation and enabling the viewfinder to be set in any position. The viewfinder contains a 5in picture tube and associated e.h.t. supply circuits, scanning generators and



4½in "Image Orthicon" pick-up tube for "BD687" television camera

amplifier which are fitted on to a hinged frame. A tube can easily be changed when the viewfinder is in position on the camera. A simple cover fits over the frame and is readily removable. A viewing hood fitted with a detachable plastic lens having a magnification of two, clips on to the end of the unit. All controls are arranged around the hood, and are edge type ; no linearity control is required. Six "Perspex" indicators are arranged along the lens edge to give cueing information to the cameraman : they indicate which lens is in use (four indicators) and whether the camera is "on-the-air" or switched to preview. Connection between camera and viewfinder is made by means of two flexible plug-in leads. The viewfinder is removed from the camera by means of a quick-release device.

The lens turret is built on a light alloy casting which actually forms the front of the camera, and accommodates four lenses set on a 10in diameter circle to allow any lens combination from 2in to 40in to be used ; they may be fitted with hoods without any part thereof appearing in the picture. Each lens may be speedily removed by a half-turn on each of two knurled nuts. In our illustration the taking lens can be seen in the bottom left-hand corner.

Two filter wheels are included in the turret, one being "fixed stop," the other variable. The "fixed stop" wheel has eight positions which may be used for neutral density or colour filters, or alternatively, left blank. It is manually operated from the front of the camera. The other filter is circularly graded, having a 10 : 1 light transmission range and is remotely operated from the camera control position. This enables the iris to be set for a correct depth of focus, the amount of light depending on the filter setting. This technique marks an advance over conventional remote iris control. Remote operation of camera focus is available as an optional extra. This facility, combined with the remote turret rotation and remote light control already described, provide a fully remotely controlled camera if required. The lens turret is held in position by means of four bolts and may be quickly removed for transport or tube changing purposes. Two cue lamps are fitted to the front of the turret.

As the image brightness on the photo-cathode is increased the signal amplitude (as observed, e.g. on a waveform monitor) at first increases in a linear manner until a point is reached at which it tends to level off. Any increase in image brightness beyond this point will not cause a greater signal output. The characteristic is similar to that of a normal receiver with good delayed A.G.C. It is a valuable feature of the "Image Orthicon," since it means that the scene illumination can change by large amounts without calling for any particular attention from the control operator or the cameraman. It is generally desirable to operate the tube so that peak high-lights come at or above the "knee" of the characteristic curve. Although the signal amplitude is limited by this characteristic, white detail is preserved by electron redistribution effects. The "Image Orthicon" tube is inherently free from variable shading effects. The slight residual shading effects are independent of picture content and can be corrected by virtually pre-set controls.

The electronic viewfinder comprises three main circuits, each of conventional design ; they are : a vision amplifier feeding the grid of the picture tube, a field scanning saw-tooth generator and output amplifier, and a line scanning saw-tooth generator and output amplifier, the latter including an e.h.t. generating circuit.

In operation and construction the new 4½in "Image Orthicon" resembles very closely the smaller existing 3in tube. The tube is cylindrical, having a maximum diameter of 4½in and an overall length of 20in. It can be regarded as consisting of three sections ; the image section containing the photo-cathode, image focusing electrodes and target ; the scanning section and the gun and multiplier section. The image section of the 4½in tube has been made longer than that of the 3in version ; within this section is incorporated an arrangement whereby an electron optical magnification of the image takes place. The area of the image on the target is approximately three times that of the optical image projected upon the photo-cathode, the magnification being carried out by a combination of electrostatic and electromagnetic fields. Advantage is also taken of the longer path between photo-cathode and target to provide two loops of focus ; this eliminates "electron ghosts." The scanning section of the tube is bounded by the wall coating, which serves as the focusing grid for the electron beam. The target end of the wall coating is closed by a fine electron-permeable screen, termed the field mesh. It is effective in eliminating edge effect and, in addition, facilitates the defocusing of the No. 1 dynode, and improves the beam landing. The gun-multiplier assembly is basically the same as that employed of the smaller tube. Some minor modifications have been introduced to ensure that saturation does not occur owing to the increased beam current required. Connections to the tube are made through a standard fourteen-pin base and a special eight-point shoulder socket.

Heavy Welding Positioner

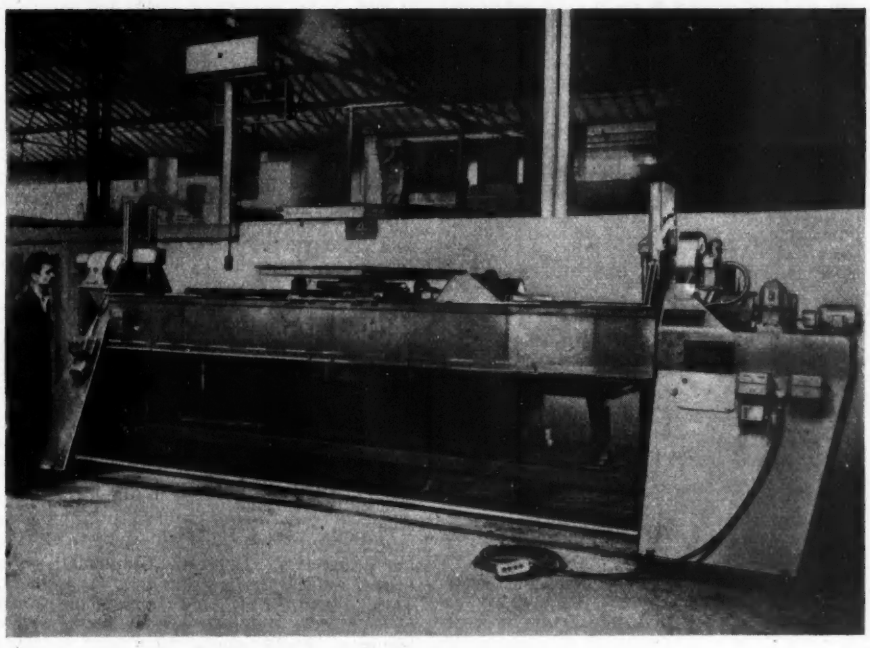
PARTICULARS have been received from Donald Ross and Partners, Ltd., 1–3, Arlington Road, London, N.W.1, of the largest welding positioner it is now making in the "Twinner" range of equipment. In this positioner mechanical means are provided for balancing heavy loads by moving the workpiece to any position on the cross head by means of a light-duty transmission system.

As can be seen in the illustration below, the main cross head carries a square work table supported at the centre on heavy-duty Timken bearings and by four outboard rollers. The work table is rotated through worm reduction and bevel gearing enclosed within the cross head. A heavy friction band is fitted to prevent the table revolving too freely when loaded and means of hand rotation is also provided.

The cross head is raised and lowered in its main frame by lead screws situated in the vertical members and driven by a geared motor unit. When using the machine a work piece is normally balanced to within a small distance on the rotational axis of the work table. The cross head is then raised until its centre of gravity with that of the work table and work piece is in line with the trunnions supporting the main frame on the end pedestals. In this position all moving parts of the machine are in balance and the small power units fitted can rotate and tilt the work piece through a full circle on both axes if required.

A slipping clutch is fitted on the tilting movement so that if the work piece has not been properly balanced the power unit will not be overloaded. A push button remote control is provided so that welding operator can control movement of the workpiece from wherever he is working.

The 15ft gap between pedestals can be increased or reduced to meet special requirements and the maximum working load with a high factor of safety is stated to be 6 tons.

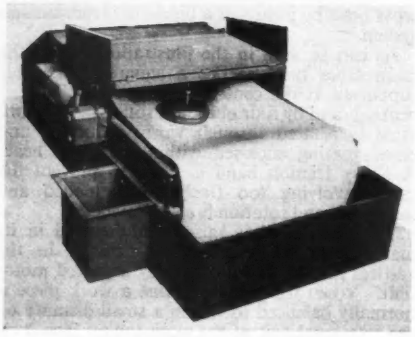


6-tons capacity welding positioner with load balancing means

Clarifier for Grinding Machine Coolant

A CLARIFIER, which can be fitted to all types of grinding machines to remove contamination in the form of finely suspended particles of swarf and dust from coolant, is now being made by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

The general construction of the clarifier can be seen in the accompanying illustration. It has an ample coolant storage capacity so that the settling tanks normally fitted to machines can be dispensed with and the coolant pump can be fitted directly into the compartment provided on the side of the clarifier. The unit is of strong sheet steel construction and whilst a grinding machine is in operation the polluted coolant, leaving the work piece, flows into a trough of special filtering material carried on an endless wire mesh conveyor. The filtering medium



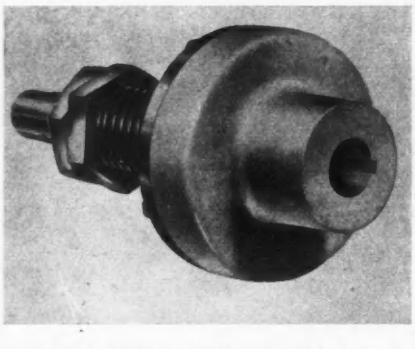
Clarifier for grinding machine coolant

retains all swarf and abrasive dust on its surface but is sufficiently porous to permit a free and uninterrupted flow of filtered coolant into the sump of the clarifier, whence it is returned by pump to the grinding head. As the filtering medium becomes saturated the fluid level in the trough rises and lifts a float. At a pre-set height this float operates a micro-switch and an electric motor moves the wire mesh conveyor forward to provide a clean filtering trough, and the contaminated filtering medium is deposited into an open sludge box at the end of the clarifier.

The four standard models of these clarifiers being made have capacities of 500, 1000, 1800 and 3000 gallons per hour. A larger model now being designed will accommodate a coolant flow of 4800 gallons per hour. The approximate flow rates given are for normal soluble-oil coolants and naturally depend on the stock removed and viscosity of the coolant.

Torque Limiters

A RANGE of torque limiters to prevent damage to machines and drives against the effects of accidental overloading is now made by Fords (Finsbury), Ltd., Chantry Avenue, Kempston, Bedford. These torque limiters can be adjusted to transmit any desired torque within fairly wide limits and they automatically disengage directly the preset torque is exceeded. They can be used as couplings in shafts, combined with vee-pulley, chain sprocket or gear drives, or combined with cut-out switches to stop a motor when an overload occurs. When the overload is cleared the limiters automatically reset to transmit power.



Torque limiter which can be adjusted to transmit any desired torque between 100 lb-in and 400 lb-in

In this design of torque limiter power is transmitted between a driving and driven member through balls held in engagement by a spring. If during operation the torque exceeds the limit set by the pressure of the spring the balls move back to further compress the spring and disengage the drive. Spring pressure is adjusted by means of two locking nuts on the shaft of the unit.

The typical torque limiter illustrated below is adjustable to transmit any desired torque between 100 lb-in and 400 lb-in, and has a 1in shaft at one end and a 1in socket at the other. It weighs about 12¼ lb and is 10¼in long by 4½in maximum diameter. Other limiters made in this range cover torque transmissions both below 100 lb-in and above 400 lb-in.

Indian Engineering News

(By Our Indian Correspondent)

Problems of River Kosi

The Kosi River, like most Himalayan rivers, has given a good deal of trouble to people living on its banks. Unlike other Himalayan rivers, however, there has been little unanimity on the best means of tackling the ever-present problem of its floods. The contradictory recommendations of engineers from time to time about this make interesting study. The Kosi project as placed before the House of the People last month comprises a barrage at Hanumannagar but its more important item is the 70-mile long flood protection embankments on either side of the "oscillating" river. This stage of the project will cost Rs. 40 crores (£30,000,000) and will take five to seven years for completion.

Fifty years ago, when the first attempt was made to tackle the problem, experts at a conference held in Calcutta considered embankments of doubtful efficacy. The conference, in fact, came to the dismal conclusion that nothing much could be done to control the course of this big river with its numerous channels. In 1937, when, too, a conference was called by the Government of Bihar, the state through which the river runs, the chief engineer was so averse to embankments that he wished all temporary bunds could be removed as they did "more harm than good." He thought that embankments merely transferred troubles from one area to another, and gave rise to a "false sense of security." The way engineering opinion has been reversed during the last few years is shown by the fact that the first stage of the proposed project stresses the importance of embankments as main protection against floods and that most of the money will be expended on them.

Although the problem river has been in the news off and on for over half a century, the real inquiry into the river's ravages began after Lord Wavell, then Viceroy, flew over the flooded areas of Bihar in 1946 and decided that something must urgently be done. Investigations, jointly conducted by Indian and foreign experts, resulted soon after 1947 in a scheme to build the highest dam ever attempted in the world, at Barahkshetra. However, this proposal in its turn met with criticism, and the experts of the advisory committee suggested the alternative of a low dam at Belka. This was to be 85ft high in place of the 783ft high dam at Barahkshetra.

The latest proposals, however, have put out of the picture both the high as well as the low dam. Several reasons have been given why no dam, high or low, would serve the purpose. First, the 85ft dam at Belka would only have moderated the peak flood of 950,000 cusecs to 460,000 cusecs. Last year's experience showed that even a flood of 250,000 cusecs can cause much havoc. Secondly, the floods are so sudden that, at times, prior warning of their approach, it is felt, would be inadequate to enable effective operation of the flood-gates at the Belka dam. Unmoderated floods, it was feared, would therefore pass over the spillway. Thirdly, both the high and the low dams would lie within the region of earthquakes of severe intensity. Major shocks have been recorded during the last hundred years, the latest being in the last week of March this year. Fourthly, the Belka dam also presented a problem of foundations as it would have literally rested on a sandy base. The Barahkshetra, on the other hand, has been given up, among other reasons, on account of the cost involved. It is almost impossible for India to embark on a project of a 783ft high dam at a time when more dams than ever before are going up all over the place, including one of the largest in the world, the Bhakra-Nangal on the Sutlej River.

In evolving the new project, the Central Water and Power Commission has relied on the experience of similar embankments abroad and in India. The general conclusion is that embankments do not produce any general and permanent raising of the bed over a century. The River Po, in Italy, has been studied from this point of view for over a century. Fantoli, who has gone into the matter in great detail, has said that during the century preceding 1907 only one variation of a permanent character stood out perceptively and decisively—a lowering of the water level due to a decline in the flow of the river. No modification of the bed has been observed. On the Mississipi in the U.S. it has been observed that the river cross-sections plotted over a number of years, do not reveal any material modification of the channel. Indian experience also corroborates these foreign observations. Professor P. C. Maholanobis, in his study of the behaviour of the Mahanadi, between 1868 and 1929, found that the average variation in the level per century was about an inch, although dykes had existed in the river for more than a century. The Damodar River, which is also dyked along its left bank, also supports the theory. The only contrary indication comes from China, where the Yellow River is said to be rising about a metre per century, the surrounding country, too, being raised by the silt deposited when water spreads through breaches in the dykes.

A start on the Kosi is expected to be made some time this year and the work should gain momentum as other projects approach completion and are in a position to release some of their skilled labour and materials. The only difficulty arises at present from the location of the project and the political problem that it raises. The barrage is almost entirely in Nepal but, since the Government of India is assuming full financial responsibility for the project and since Nepal stands to gain from it to an extent of about 300,000 acres of irrigated land and a canal system, it is not believed that the difficulties will be unsurmountable.

Development of Atomic Energy

The Atomic Energy Commission has drawn up a plan for the development of atomic energy in India during the next four years. The plan, which aims at a general increase in the Commission's activities including the setting up of an atomic energy establishment, has been approved by the Planning Commission. The establishment, it is understood, will be set up at Trombay, about 15 miles from Bombay, where two oil refineries and a thermal power station are now being erected. The research laboratories of the Commission and pilot plants for some of the processes in which it is interested will be located in this area. Work on the site has already begun.

Among the new projects to be taken in hand are the setting up of an atomic reactor and the construction of a million-volt Van der Graaf generator. Already a cascade generator has been installed in its temporary quarters in Bombay, an electrostatic beta-rays spectrometer has been built and a million-volt model cyclotron, operated for the first time last year, has been remodelled.

Two new divisions of the Commission have been formed, one, the Medical and Health division for the study of protection against radiation hazards and, second, a Biology division for fundamental research on the biological effects of radiation. The monazite processing plant in Travancore-Cochin will now be followed by a thorium-uranium plant at Trombay estimated to cost about £400,000. Orders for most of the machinery and equipment have been placed and the plant which will form the nucleus of the atomic establishment is expected to go into production later this year.

Industrial and Labour Notes

Overseas Trade

The Board of Trade states that exports of United Kingdom goods in April are estimated to have reached a value of £225 million. There were only twenty-four working days in April, compared with twenty-seven in March, but the value of exports was nevertheless slightly above the monthly average in the first quarter of the year. Imports in April have been valued provisionally at £284 million, and the Board of Trade says that in the first four months of this year the value of imports was much the same as in the corresponding months of last year. The value of re-exports in April was £8,000,000, so that the excess of imports over total exports and re-exports was £51,100,000. In the first four months of this year, the excess of imports over exports averaged £42,800,000 a month, compared with £57,600,000 a month in the corresponding period of last year.

International Conference of Manufacturers

The Council of European Industrial Federations has arranged the second international conference of manufacturers which will be held in Paris in the early part of next week. The first conference of its kind was held in New York in December, 1951, to provide opportunity for the exchange of views on problems common to American and European industry.

Next week's conference is to be attended by about 200 delegates from the U.S.A. and by representatives of all the industrial federations in the O.E.E.C. countries and Finland. The British delegation will consist of twelve members nominated by the British Employers' Confederation and the Federation of British Industries. For the major part of the conference, the delegates will be divided into four groups, each of which will discuss one of the following subjects : —Human relations within the enterprise ; raising of standards of living and stability of employment ; private enterprise and its relations with government ; broadening of markets and investment overseas.

Industrial Coal Consumers' Returns

The Minister of Fuel and Power has decided that smaller industrial and commercial consumers of coal, coke and oil may now be relieved of their obligation to make returns concerning their consumption and stocks. Since 1940, consumers of 100 tons a year or more of solid fuel have been required to make these returns. From now on, however, returns will be made only by larger consumers (consumers of 1000 tons a year or more of coal, or 200 tons a year or more of hard coke, or 500 tons of oil). It is stated that this will cut down the number of firms making returns by about three-quarters, but that the information still becoming available to the Ministry of Fuel and Power will account for 88 per cent of industrial coal consumption and about 98 per cent of hard coke consumption.

Capital Expenditure in Coal Mining

In the course of his presidential address to the British Association of Colliery Management on Friday last, Mr. S. Walton-Brown deplored the slow rate of capital expenditure in the coal mines. It was, he said, hampering output. The projected investment based on the "Plan for Coal"—which Mr. Walton-Brown described as a far from ambitious document—was being effected at a rate of progress which no commercial undertaking would have accepted. That investment, Mr. Walton-Brown said, still continued to lag behind schedule, although he thought it might be turning the corner at last.

He went on to refer to a statement by the Minister of Fuel and Power that it took up to ten years to bring a new pit into operation, and about seven years to complete a major reconstruction. That, Mr. Walton-Brown suggested, was a situation which urgently needed amendment. Civil engineers, he said, could be used in this work to great advantage. So far, Mr. Walton-Brown remarked, the National Coal Board had existed as an octopus, stretching out tentacles here, there and everywhere, but, like the octopus, without power to stand. Somehow or other it must be changed into an entity with financial feet, and must learn to stand upon them without repeated increases in the price of coal. The only way to reduce prices and avoid losses was to achieve a higher production basis as early as possible.

Coal Imports

The Parliamentary Secretary to the Ministry of Fuel and Power was asked in the House of Commons on Monday how much coal was imported in the year ended April 30th last, and at what cost. He was also asked how much coal the Ministry proposed to import, or had consented to import, in the year ending April 30, 1955.

In his reply, the Parliamentary Secretary, Mr. L. W. Joynson-Hicks, stated that in the year ended April 30th last approximately 792,000 tons of coal had come into the country at a "landed" cost of about £5,000,000. The main sources of these supplies were Belgium, France and Western Germany. None had come from Eastern Germany. About 67,000 tons came from Western Germany and 2300 tons from Poland. Mr. Joynson-Hicks added that, under present arrangements, there was a quantity of about 200,000 tons of imported coal still to come in, but that the Minister had not yet announced any future import programme.

Industrial and Commercial Finance Corporation

A statement by Lord Piercy, chairman of the Industrial and Commercial Finance Corporation, which has been circulated with the annual report, comments on the recent economic background and its relation to the Corporation's performance. The statement says that powerful factors have operated to cause changes in the financial conditions of industry ; falling commodity prices ; the effect of the Bank Rate upon business confidence, and the decline in 1953 in the profitability of business. These factors, Lord Piercy comments, have had two results : a great increase in the liquidity of businesses and a further damping of investment, already at a low level, in manufacturing industry at large.

The statement goes on to say that nationalised industry and the recently denationalised steel industry did a good deal of investment last year, and many of the largest industrial undertakings with long-term programmes also continued to invest. But it seems true, Lord Piercy says, that in the small, medium and medium-to-large ranges of industry which are typical of our industrial structure an indisposition to undertake fixed investment on a really significant scale has become accentuated. It is a matter of general notoriety, the statement adds, that investment in productive industry is low absolutely, and, relatively to the United States and Germany, has fallen to too low a level for our good.

Lord Piercy says in his statement that finance actually is not at the present time a principal impediment to increased investment. The hindrances are complex and it is not easy to determine the most important. The high cost of plant and building is one of them, long delivery is another, while other factors are the delays inherent in our systems of building permits, planning permission and the like. Some of these conditions will improve or can be remedied. In the way of positive inducements, Lord Piercy observes, there is nothing like putting the manufacturer in the position—if he has the profits—to write off a substantial part of the new cost at the outset.

Disposal of Trade Effluents

The Federation of British Industries has published a booklet entitled *Disposal of Waste Waters from Industrial Premises*, which brings together all the somewhat legal complications affecting the disposal of trade effluents. There are three Acts—the River Boards Act, 1948 ; the Rivers (Prevention of Pollution) Act, 1951, and the Rivers (Prevention of Pollution) (Scotland) Act, 1951—which have created the need for industries having liquid wastes to review their methods of disposal. Pollution of rivers by industrial discharges is frequently of very long standing, and the treatment of many trade wastes to the standards required by amenity and by angling interests presents industry with technical and financial problems which cannot readily be solved. The River Boards are undoubtedly showing a practical and understanding approach to the problem, and the F.B.I. urges that industry can best solve its problems by co-operating with the River Boards and local authorities.

The aim of the booklet is to explain in simple language the main requirements of the legislation and the important technical points arising therefrom, so that those in factories who are responsible for the disposal of trade effluents may be better able to discuss the problems with the authorities and work out a solution. The booklet emphasises that before firms embark on expensive treatment processes for their effluent they should obtain adequate technical and legal advice. In the long experience which the Federation of British Industries has had in advising firms on the disposal of trade effluents, there have been many examples of money spent on plant which fails to give the desired result in practice. In addition, there have been difficulties because suitable legal and technical advice was not sought before the work was begun.

Industrial Welfare Society

The thirty-first annual conference of the Industrial Welfare Society is to be held at Keble College, Oxford, from July 1st to 5th. The general theme of the conference is "Industry and Society" and the intention is to give all who are concerned with management and welfare the opportunity to consider the relationship between their work and the aims of the society in which it takes place.

The Society is also arranging two conferences for apprentices. They will be held at Keble College, Oxford, from September 2nd to 6th and 7th to 11th. The subject for both these conferences is "The Approach to Industrial Responsibility." The British Association will be holding its annual meeting at Oxford during the period of these conferences, and the Industrial Welfare Society has consequently endeavoured to establish on its platform a connection between the work of the scientist and the work of the apprentice.

Western Region Locomotive Men's Strike

An unofficial strike by locomotive crews in the Western Region of British Railways started at Newton Abbot at midnight on Sunday as a protest against "lodging turns." The arrangements for these lodging turns, it is reported, were agreed between the railway management and the Associated Society of Locomotive Engineers and Firemen, but a large proportion of the drivers and firemen attached to the Newton Abbot depot decided upon unofficial strike action, an action which is in no way condoned by their union. On Monday and Tuesday, locomotive crews at the Paddington and Bristol depots of the Western Region joined the strike, with the result that many train services from London to the West Country had to be abandoned. It has been stated that twenty new lodging turns were to be added, by agreement with the unions, making a total of about 300, compared with the 1300 worked in the area of the Western Region before the war. Despite the efforts of the unions—which continued on Wednesday—to bring about a resumption of work, a return to normal operation had not been achieved at the time of going to press.

Notes and Memoranda

Air and Water

LAUNCH OF INSHORE MINESWEEPER.—The inshore minesweeper H.M.S. " Frettenham " was launched from the Cowes shipyard of J. S. White and Co., Ltd., on May 17th. The ship has a length of 106ft 5in and a beam of 20ft 6in and is designed to operate in shallow waters.

ASSOCIATION TECHNIQUE MARITIME ET AERONAUTIQUE.—The fifty-third meeting of the Association Technique Maritime et Aeronautique will be held on May 31st and June 1st, 2nd, 3rd and 4th, at 2, Place de la Bourse, Paris. During the meeting some twenty-nine papers dealing with a wide range of subjects concerned with both practical and research problems related to ships and aircraft will be read and discussed. The programme provides for the presentation of the papers to begin on the afternoon of Monday, May 31st, and at 9 a.m. in the morning, and at 2.30 p.m. in the afternoon on the three following days.

MOTOR YACHT " ARIES."—During the next two months the motor yacht " Aries " will be making a double crossing of the Atlantic from Kingston-upon-Thames to Kingston, United States, under the command of Mr. C. Harcourt Smith. The yacht was built by Saunders-Roe in 1929 as the lifeboat " Princess Mary," and was stationed at Padstow and has a length of 61ft by 15ft beam, and a displacement of 45 tons. She was bought last year and since then has been renamed " Aries " and converted to meet the requirements of the project of a double crossing of the Atlantic by a small power-driven craft. Two Foden 120 b.h.p. diesel engines have been installed as main propulsion units and, to hold sufficient fuel for the crossing, eight tanks with a total capacity of approximately 2500 gallons and built of aluminium alloy supplied by the British Aluminium Company, Ltd., have been fitted. The question of communications has received special attention and extensive equipment for this purpose has been supplied by Rees Mace Marine, Ltd., to enable the yacht to keep in touch with radio stations throughout the world. The yacht is expected to sail on May 22nd and to arrive at New York some twenty days later and should be back in this country by July 17th.

Miscellanea

MR. D. D. HAWLEY.—We have learned with regret of the death of Mr. Douglas Digby Hawley, which occurred at Sheffield, on Saturday last, May 15th. Mr. Hawley, who was fifty-nine, had been sales director of Hadfields, Ltd., since February last.

BIRMINGHAM EXCHANGE AND ENGINEERING CENTRE.—The new Birmingham Exchange and Engineering Centre is to be opened by Lord Bennett on Thursday, June 17th. It is stated that more than 200 firms are exhibiting and that all the exhibition space has now been taken.

P.V.C. COVERED STEEL TUBING.—Steel tubing coated with P.V.C. is now being made in six standard sizes from $\frac{3}{4}$in to 1$\frac{1}{4}$in outside diameter by George Burn, Ltd., of Smethwick. At present " Burcol " tubes, as they are known, are available with the plastic coatings coloured off-white, black, red and green, although other colours can be supplied to special order.

OIL SEARCH UNDER THE SEA.—In search for underwater oil in the South China Sea two steel drilling platforms are under construction about 1 mile off the coast of British Borneo. These drilling operations are intended to discover a submarine extension of Seria Oilfield of the Shell Petroleum Company, Ltd., and the platforms are linked with shore by an aerial ropeway.

S.G. CAST IRON EXHIBITION.—A private exhibition to show the industrial uses of spheroidal graphite cast iron is being arranged by The Mond Nickel Company, Ltd., It will be held at Park Lane House, London, W.1, from Tuesday to Thursday of next week, May 25th to 27th. Tickets may be obtained from The Mond Nickel Company, Ltd., Sunderland House, Curzon Street, London, W.1.

EXHIBITION OF VOKES PRODUCTS.—An exhibition of its products is to be held by Vokes, Ltd., Henley Park, Guildford, at the Kensington Palace Hotel, De Vere Gardens, London, W.8, from to-day, Friday, May 21st, to Thursday, May 27th. Amongst the representative selection of filtration and silencing equipment to be shown will be some new products including a rock drill dust trap, a grading cyclone, and a small dust collector unit.

ALUMINIUM DEVELOPMENT ASSOCIATION.—At the annual general meeting of the Aluminium Development Association held on April 23rd, Mr. R. T. Priestman, the managing director of T. J. Priestman, Ltd., was elected president for 1954–55, and Mr. R. D. Hamer, the retiring president, was appointed vice-president. At the meeting Mr. H. Goodwin was appointed to succeed Mr. G. W. Lacy as chairman of the executive committee of the Association.

HEAVY-DUTY PULLEY BLOCKS.—We are informed by Richard C. Gibbins and Co., Ltd., Berkley Street, Birmingham, that it has manufactured four pairs of six and six sheave wire rope pulley blocks. Each pair of blocks is designed to lift 100 tons with 5in circumference wire rope. These pairs of pulley blocks, which have been ordered by Babcock and Wilcox, Ltd., each weigh 3 tons 7 cwt and have been tested to 150 tons. The blocks have grease lubricated centre pins, cast steel sheaves bushed with phosphor bronze and forged steel oval swivel eyes with anti-friction thrust washers.

MAUDSLAY SCHOLARSHIP.—The Junior Institution of Engineers states that through the generosity of the Maudslay Society a scholarship known as the Maudslay Scholarship is offered to young engineers for the purpose of assisting them in their technical education and practical training. The scholarship this year has been doubled and will be £300 for one year. Candidates must not be more than twenty-six years of age and must be engineers, or training to be engineers, wholly or mainly interested in mechanical engineering. The closing date for entries for this award is July 31st. Further information can be obtained from the Junior Institution of Engineers, 39, Victoria Street, London, S.W.1.

RELAY TELEVISION CABLE LINK FOR EASTBOURNE.—We learn that British Insulated Callender's Cables, Ltd., has made a special length of multi-core cable to form part of a link between two television relay stations owned and operated by Link Relay Vision, Ltd., in Eastbourne, Sussex. The cable was designed to minimise signal distortion and to allow for future development, including the introduction of multiple television programmes. It contains four polythene-insulated, screened-quad units and fifteen single-core polythene-insulated conductors. It is 1500 yards long and the remainder of the link consists of overhead screened and unscreened cables, which are installed on catenaries and under the eaves of houses as is usual with relay distribution networks.

CONFERENCE ON OPEN-HEARTH FLAMES.—A one-day conference on " Open-Hearth Flames and Output " is being arranged by the West of Scotland Iron and Steel Institute. It will be held at 39, Elmbank Crescent, Glasgow, on Friday, September 10th, from 10 a.m. to 4.45 p.m. The papers on which the discussions are to be based are as follows :—" Combustion and Radiation Characteristics of Oil and Coke-Oven Gas Jet Flames," by Professor M. W. Thring ; " Melting Rates in the Open-Hearth Furnace," by Mr. E. J. Burton ; " Improvements in Firing Oil and Coke-Oven Gas in the Open-Hearth Furnace," by Mr. J. A. Leys ; " Making Producer Gas a Competitive Fuel," by Dr. G. W. C. Allan, and " The Use of Various Fuels in the Open-Hearth," by Mr. W. B. Wright.

EPIKOTE RESINS.—" Epikote " resins are one of the expanding range of chemicals from petroleum and their manufacture was begun last year at the Pernis refinery of the Shell Petroleum Company, Ltd., at Rotterdam. A new plant is now under construction at the company's Stanlow refinery in Cheshire, and is expected to be in production by next spring. The resins have a wide application in finishes for a wide variety of items and these " Epikote " based finishes have flexibility, abrasion resistance and strong adhesive power. Epichlorhydrin, manufactured from propylene, chlorine and caustic solution, and diphenylol propane, made from phenol and acetone, are the base materials for the resins, which are manufactured by heating a solution of diphenylol propane in caustic with epichlorhydrin in a stainless steel boiler.

DIRECTORY OF INTERNATIONAL SCIENTIFIC ORGANISATIONS.—A revised edition of the *Directory of International Scientific Organisations* has just been issued by Unesco. It contains particulars of 264 organisations which are grouped in three main chapters—Basic Sciences, Applied Sciences and Miscellaneous. The applied sciences are subdivided into agricultural, engineering and medical sciences. In " Miscellaneous " are grouped a number of organisations whose activities enter into a number of different scientific fields or which, while not being entirely scientific, are of interest to scientists—such as Unesco itself. Organisations whose membership and activities are limited to a particular geographical area—for example, the European Council for Nuclear Research—have been placed at the end of their respective chapters under the heading of " Regional Organisations." Copies of the directory are available in this country from H.M. Stationery Office, price 13s. 6d. each.

MINISTRY OF WORKS EXHIBITIONS.—During the next twelve months building exhibitions, arranged by local organisations in co-operation with the Ministry of Works, will be held in technical colleges throughout the country. The first of these will be at Liverpool from May 26th to June 2nd, followed by others at Sheffield (June 21st to 26th), and Coventry (September 13th to 18th). Three more are under consideration. The Liverpool Exhibition will be held at the City of Liverpool College of Building, Clarence Street, Liverpool, and will be opened at 11 a.m. on Wednesday next, May 26th, by Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works. The exhibition will include displays of work by individual students or groups of students pursuing courses in building, civil and municipal engineering, structural engineering, architecture and surveying. Displays and demonstrations of experimental work on materials, building services and structures, will also be shown. The Ministry of Works will also provide several exhibits. The exhibition will be open from 11 a.m. to 8 p.m. daily (except Sunday) and admission is free. The College workshops will be open to visitors, and films dealing with building and civil engineering subjects will be shown each day.

Contracts

THE BURNTISLAND SHIPBUILDING COMPANY, Ltd., has received an order from the Australian Steamships Proprietary, Ltd., to build a single-screw general-purpose cargo ship of 3450 tons deadweight. The ship will have a length of 310ft by 44ft 6in breadth moulded by 20ft 10in depth moulded and a draught of 18ft 9in and will be propelled at a speed of 11 knots by a nine-cylinder British Polar diesel engine of 1440 b.h.p.

THE GENERAL ELECTRIC COMPANY, Ltd., announces that an order has been received by its Fraser and Chalmers Engineering Works, Erith, Kent, for the supply of a complete coal preparation plant for the National Coal Board, South-Western Division, to be installed at the Maesteg site in South Wales. It will operate as a central washery, serving four pits. The plant will include a 12ft. diameter Chance cone for three-product separation. The plus 8in coal will be hand cleaned, the 8in by 1$\frac{1}{2}$in will be washed in the 12ft cone, and the 1$\frac{1}{2}$in by 0in fines will be used for power station fuel. Provision has been made for cleaning the 8in by $\frac{1}{4}$in coal in the Chance cone at a later stage and installing froth flotation plant to deal with the $\frac{1}{4}$in by 0in. Input to the washery will be 250 tons per hour of raw coal, the cone having a capacity of 120 tons per hour of 8in by 1$\frac{1}{2}$in coal. The contract includes a steel-framed building to house the plant, conveyors, shaker screens, crushers, all electrical control gear, civil engineering work, lighting, power wiring and heating.

Personal and Business

MR. G. R. MARSH has been appointed managing director of Wickman, Ltd., Coventry.

THE DE HAVILLAND ENTERPRISE announces the appointment of Mr. P. W. Grigsby as production manager at the Hatfield aircraft factory.

THE EARTH BORING MACHINE COMPANY, Lake Works, Portchester, Hants, has now been formed to market the " Magco " earth boring machine.

MR. W. MURE has resigned from the boards of the Wolverhampton Metal Company, Ltd., and its subsidiary, James Bridge Copper Works, Ltd.

H. WIDDOP AND CO., Ltd., Keighley, announces the appointment of Commander (E.) L. J. F. Howard-Mercer, M.I.Mech.E., as assistant to Mr. J. T. MacLeod, the managing director.

MARTIN, BLACK AND CO. (WIRE ROPES), Ltd., Coatbridge, has opened a Midlands office at 4, Low Pavement, Nottingham (telephone, Nottingham 47293). Mr. H. Arkless is Midlands manager.

MR. WALTER FIDKIN, M.I.C.E., is retiring, on July 31st, from the position of chief engineer of Southend Waterworks Company. Mr. Adam Hope, A.M.I.C.E., has been appointed to succeed him.

CARRON COMPANY, Falkirk, announces the appointment of Mr. E. J. Leaver as manager in succession to Mr. B. W. Payne. Mr. Leaver joined the company in 1942 and has been assistant manager since 1952.

MR. S. A. ROBERTS, general manager of the B.S.A. Tools Group, has been appointed to the boards of the following companies in the group : B.S.A. Tools, Ltd., Leo. C. Steinle, Ltd., and Cardiff Foundry and Engineering Company (1947), Ltd.

SAMUEL OSBORN AND CO., Ltd., Sheffield, states that Mr. K. A. Ballard has been appointed a special representative for the sale of steel castings. He is attached to the company's London office at Donington House, Norfolk Street, Strand, W.C.2.

W.K.M. VALVE CO. (BRITAIN), Ltd., has been formed to represent the international interests of the W.K.M. Company, Houston, Texas. Mr. R. Adams, M.I.Mech.E., is the technical director and general sales manager of the new company, the offices of which are at 10, Dover Street, London, W.1.

THE DISTILLERS COMPANY, Ltd., states that most of the divisions and subsidiary companies in its industrial group are now moving into Devonshire House, Mayfair Place, Piccadilly, London, W.1 (telephone, Mayfair 8867). Following these changes, Magnesium Elektron, Ltd., will move to Distillers House, 20–21, St. James's Square, London, S.W.1 (telephone, Whitehall 1040).

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION states that Mr. E. W. Voice has been appointed head of the ironmaking division in succession to Dr. H. L. Saunders, who has retired because of ill health. Mr. Voice, who was on the B.I.S.R.A. staff from 1946 to 1951, is at present assistant director of the National Coal Board's central research establishment at Isleworth.

TYER AND CO., Ltd., and B.P. AND TYER'S SIGNALS, Ltd., state that Lieut.-Colonel Claud Hardie has resigned from the office of joint managing director of both companies, but will continue to serve as technical director of each. Mr. D. S. Bennett, managing director of both companies, has been appointed to the boards of P.A.M., Ltd., Guildford, and Resinoid and Mica Products, Ltd., Balsall Heath, Birmingham, 12.

SHELL-MEX AND B.P., Ltd., announces the following appointments :—Mr. R. G. Woodman, aviation manager, Southern division ; Mr. G. A. Baxter, assistant manager, kerosene and agricultural department, head office ; ; Mr. V. G. White, white products (general) manager, London division ; Mr. E. Rendall, Birmingham branch manager ; Mr. R. F. Knight, Oxford branch manager ; Mr. L. C. Hoare, manager, purchasing department, head office.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., states that its maritime business, which has hitherto been dealt with by the central division, has now been taken over by a newly formed maritime division. Mr. G. R. Tyler has been appointed manager of the maritime division and is succeeded as manager of the central division by Mr. R. H. Deighton. Mr. J. Watt has been appointed chief engineer in the maritime division. The company's services equipment division is now known as the radar division. Mr. H. J. H. Wassell has been appointed chief engineer in that division. Other appointments announced by Marconi's Wireless Telegraph Company, Ltd., are : Mr. R. E. Burnett, assistant to the general manager ; Mr. E. R. L. Lewis, deputy manager, education and technical personnel ; Mr. R. G. Hulse, deputy principal of Marconi College and director of studies ; Mr. J. Lindsay Scott, chief of technical personnel recruitment.

British Patent Specifications

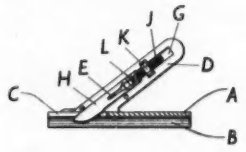
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

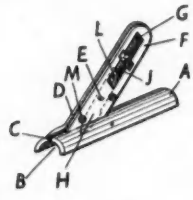
Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

ELECTRICAL ENGINEERING

704,488. November 21, 1951.—A Device for Slitting the Coverings of Electric Cables, The Plessey Company, Ltd., 56, Vicarage Lane, Ilford, Essex. (*Inventor Horace Bingham.*)

The invention relates to a device for slitting the coverings of electric cables, provided with adjusting means for varying the effective depth of the cutting tool. Referring to the drawings, the device comprises a guide plate *A* about 3in in length, with a channel *B* and a longitudinal slot *C* in the well of the channel. A clamp plate *D* fitted with a guide pin *E*, is attached to the guide plate so that it is inclined as shown, and its inner surface is flush with the slot *C*. A second clamp plate *F* is removably





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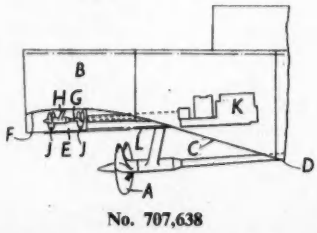
attached to the fixed plate *D*, and the two plates are provided with a slot *G*. A slotted cutter *H*, coupled to a threaded rod *J*, and a nut *K* is provided as shown. One end of the rod *J* is cut away and slotted longitudinally, and is fitted with a guide pin *L*. In assembling, the cutter and adjusting screw are placed on the inner face of the fixed clamp plate *D* so that the end of the cutter projects through the slot *C*, and the adjusting screw is housed in the slot *G* in the fixed guide. The removable clamp plate *F* is then secured to the fixed plate *D* by screws *M*, after tightening of which the device is ready for use. The cable is pressed into the curved channel and the device is moved in the opposite direction to the inclination of the clamp, so that the cutter penetrates and cuts the outer cover of the cable longitudinally. The slitted portion of the cover is then cut off by shears or scissors.—*February* 24, 1954.

MARINE ENGINEERING

707,638. March 9, 1950.—Improvements to Ships, John I. Thornycroft and Co., Ltd., Thornycroft House, Smith Square, London, S.W.1, and Frederick George Parsons, of "Maranatha," Ower, Romsey, Hampshire.

The drawing shows a longitudinal section illustrating the application of the invention to a ship having twin main screw propellers. The vessel has twin main screw propellers *A* and a stern structure *B* which extends above and beyond the main propellers. The bottom *C* of the stern structure slopes up from the bottom *D* of the main part of the

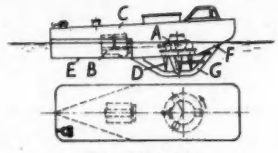


No. 707,638

hull and the stern structure is provided with a channel *E* recessed into its underside to form a tunnel, which, at its forward end, merges into the sloping part, and at its rear *F* has a slight downward inclination towards the rear. In this channel an auxiliary propeller shaft *G* extends, the outer end of the shaft being supported by a bearing arm or bracket *H* and carrying an auxiliary screw propeller *J* which is housed within the channel. The auxiliary propeller shaft may carry two or more propellers *J* arranged in tandem. The propeller shaft *G* is driven by a suitable auxiliary power plant *K*, the arrangement being such that the propeller shaft *G* is parallel, or substantially parallel, to the inclined part *F* of the channel. When the auxiliary screw propulsion means is not in use, the entrance of the channel *E* may be shut off at the bottom by movable doors *L* to obviate resistance of the auxiliary propellers *J* when the main screw propellers are in operation.—*April* 21, 1954.

707,670. November 9, 1951.—Vane Wheel Propeller Drives, J. M. Voith G.m.b.H., Heidenheim, Brenz, Germany.

Vane wheel propellers have previously been used for driving a variety of types of ship, including tug boats. Hitherto, the exclusively adopted arrangement of the propeller has been at the stern of the ship. By means of the invention, however, means are suggested by which it is possible to achieve a good forward drive efficiency with high course stability and a small bow wave. Referring to the drawings a Voith-Schneider propeller *A*, driven by the motor *B*, is positioned in the fore half of the ship's hull *C* in such a manner that only the blades *D* project from



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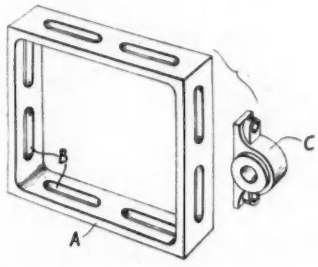
the flat ship's bottom *E*. The bottom rises directly forward of the propeller so that the field of acceleration of the flow to the propeller can form itself directly in front of the bow and have a suction action. A further advantage consists in that only a small bow wave is formed, so that the ship can travel in narrow waters, such as canals, at speed without endangering the banks. The aft part of the ship is wedge-shaped up to a point above the line of flotation and widens out in a box-like manner as shown. As protection against damage to the propeller blades the blades are surrounded by a protective cage *G* of flat tubular struts. A further example shows a tug provided with two adjacent blade wheel propellers.—*April* 21, 1954.

BEARINGS AND SUPPORTS

707,823. December 17, 1951.—Bracket for Mounting Plummer Blocks, Herbert Kohn Staub, 59, Farringdon Road, London, E.C.1.

Referring to the drawing, the bracket consists of a square die-cast metal frame *A*, with two elongated slots *B* in each side. The slots in any of the sides may be employed in conjunction with bolts to clamp the



No. 707,823

frame to a suitable flat base member, the slots in any of the three remaining sides thus being available for the mounting of a plummer block *C*. The plummer block may be mounted on the outside or the inside of the frame or in a number of desired positions along the length of a side of the frame. The specification also shows a bracket in the form of a closed semi-circular frame.—*April* 21, 1954.

METALLURGY

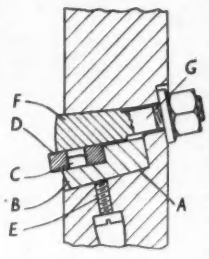
707,765. September 10, 1951.—An Improved Solder, Stanley Francis Warren, 16, Kensington Square, London, W.8. (Communicated by *Soldalium (Proprietary), Ltd., 24, Ansteys Buildings, West Street, Durban, Natal, South Africa.*)

The object of the invention is to provide a solder for aluminium and aluminium alloys and other metals. In this solder the proportion of zinc to tin is 9 : 1. A quantity of zinc is melted in a receptacle to a temperature of 550 deg. Cent. and maintained at that temperature for fifteen minutes. The molten zinc is then cooled to a temperature of 450 deg. Cent., at which the tin is added to it. The melt is then slowly heated to a temperature of 600 deg. Cent. and the constituents are thoroughly mixed. The melt can then be poured into a water-cooled mould, to produce rods of a suitable cross section. The solder may be used without a flux for soldering aluminium and its alloys, zinc-based die-cast metals and pewter. When soldering cupriferous metals, such as brass or bronze to aluminium, the cupriferous metal should first be tinned with a layer of tinman's solder in the usual manner. The solder of the invention is applied to a surface of the aluminium and the treated surfaces are placed together and heated until the solders fuse together.—*April* 21, 1954.

TOOLS AND WORKSHOP APPLIANCES

707,691. April 4, 1952.—Facing Heads, Steel and Cutting Metal Import Trading Company (Stahag), 489, Hohlstrasse, Zurich, Switzerland.

The facing head comprises a cutter head with four frusto-conical bores *A*, the longitudinal axes of which are inclined to the axis of the head. In each of the bores is a wedge-shaped holder *B* which has a half-round cross section. The holder is provided with a mandrel *C* on which is rotatably mounted a cylindrical hard metal ring *D*. The holder *B* can be secured in the bore by means of a screw *E*. In each bore there is a wedge *F* which is half-round in cross section. The wedge is provided with a cylindrical part *G* on the thread of which is a nut. By tightening of the nut the wedge and holder are clamped in the bore and the ring *D* is held fast and cannot rotate. The ring lies with at least two-thirds of its end faces clamped between the holder and the wedge. The use of a hard metal ring provides two circular cutting edges, each of which cuts with part only of one of its cutting edges at a time.—*April* 21, 1954.



No. 707,691

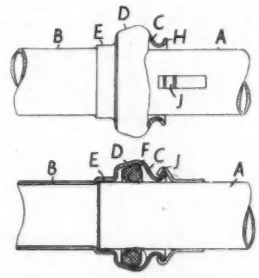
707,780. November 26, 1951.—Diamond Cutting Tools, N.V. Philips' Gloeilampenfabrieken, Emmasingel 29, Eindhoven, Holland.

The invention relates to cutting tools in which a single diamond is set in an alloy consisting of 76 to 83 per cent copper and 17 to 24 per cent tin, known under the name of bell metal. This alloy has the advantage that in the first place it has a comparatively low melting temperature of about 750 deg. Cent., so that the diamond is not damaged when set in the alloy. Furthermore, the alloy has a proper contraction, so that the diamond is rigidly secured. It has been found that a diamond in a holder manufactured from the alloy can be ground without being removed from the holder. The invention can be applied to straight or rotary tools.—*April* 21, 1954.

TUBE AND ROD COUPLINGS

708,142. November 2, 1951.—Couplings for Tubes and Rods, Rohrbau Mannesmann G.m.b.H., 16–18, Bleichstrasse, Düsseldorf, Germany.

As the drawing indicates, the end of the plain tube *A* is situated in the sleeve tube *B*. The sleeve tube comprises an end flange *C* and a conically tapering sleeve portion *D* adjoining the end flange. A short cylindrical enlargement *E* of the tube may be provided to guide and limit the distance to which the plain tube is inserted. A sealing ring *F* of substantially circular cross-section with a flattened side is provided in the cavity formed by the tube parts. As shown by the dotted line in the lower view, the



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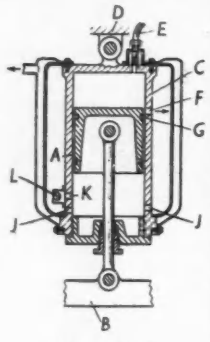
sealing ring lies at the point at which the sleeve diameter is greatest prior to the introduction of the plain tube end, the flattened side being at an angle to the sleeve portion. On insertion of the plain tube the distorted sealing ring tends to return into its initial position and thereby effects the sealing. The coupling can be released in a very simple manner by turning one of the connected tubes and at the same time withdrawing it from the other. The edge *H* of the end flange *C* is turned over and has slots through which the lugs *J* secured to the plain tube end *A* are passed. On rotation of the tubes in relation to one another, a bayonet connection providing an additional axial locking action is obtained. Modified designs are also shown in the specification.—*April* 28, 1954.

ROAD TRANSPORT

708,071. May 31, 1951.—PNEUMATIC SUSPENSIONS FOR VEHICLES, Friedrich Nallinger, 22, Relenbergstrasse, Stuttgart, Germany.

As shown in the drawing, a piston *A* is pivotally connected to the vehicle axle *B* by means of its piston rod and slides in a cylinder *C*, connected to the chassis *D* of the vehicle. Compressed air is supplied to the cylinder through a pipe *E* and a non-return valve. An outlet port or ports *F* controlled by a piston ring *G* so as to serve as a throttling point for the air flow, permits escape of the air. When the vehicle is in the position of rest, the piston *A* will adjust itself, as a result of the constant entry of compressed air, to that mean position in which the port *F* is just uncovered by the piston ring *G*. From the port there will in all cases be discharged an amount of compressed air such that inside the cylinder a pressure will be produced which maintains equilibrium with the portion of the load on the vehicle which is distributed to the spring cylinder. When the loading of the vehicle is increased, so that the cylinder and piston tend to move in relation to one another and temporarily close the port *F*, the cylinder space above the piston will be filled with compressed air. The lower part of the pneumatic spring is constructed as a shock absorber. The air can flow into or out of the space beneath the piston through throttling ports *J*. In order further to increase the damping or shock-absorbing action, an additional port *K* may be provided and fitted with a valve *L* which is controlled or which automatically opens on the upward stroke of the piston. During the upward stroke of the piston there is a relatively slight throttling of the intake of air through the port *K*, while during the downward stroke there is a relatively intense throttling due to closing or partial closing of the valve *L* so that there is damping of the springing movement.—*April* 28, 1954.



No. 708,071

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

DERRICK CRANES (HAND OPERATED)

No. 327, Part 2 : 1954. Price 6s. This revised standard follows similar lines to the previous editions in that it indicates the minimum requirements for hand-operated derrick cranes of normal design and is intended to secure the general observance of such fundamental principles as appear desirable to secure reliability and safety without hampering the freedom of the crane maker in his selection of the most appropriate design for the purpose in view.

The standard deals with hand-operated cranes of the Scotch derrick and guy derrick designs, and specifies requirements for the crane structure and moving parts. Hoisting equipment and brakes are dealt with and an appendix gives the requirements to be observed when a hand-operated crane is converted to power operation.

The clauses on electrical wiring and cables have been brought into accord with the twelfth edition of the Regulations for the Electrical Equipment of Buildings published by the Institution of Electrical Engineers, and the appendix on the design of struts has been revised so as to follow the general method of application of the Perry-Robertson formula for struts adopted in other British Standards.

CHROMIUM - NICKEL HEAT - RESISTING STEEL TUBES (SUITABLE FOR WELDING) FOR AIRCRAFT

No. T.61 : 1954. Price 1s. 6d. This is a new specification for steel tubes for aircraft. It replaces D.T.D. 491.

CHILLED IRON SHOT AND GRIT

No. 2451 : 1954. Price 2s. The primary purpose of this standard is to assist in overcoming the difficulties which have been experienced by users in obtaining uniform grades and sizes of chilled iron shot and grit for use in shot blasting and kindred applications. It is mainly concerned with the separation and sizing of the chilled shot and grit and designating grade and size numbers. It has also been considered desirable to include requirements for hardness.

The Institution points out that the term "steel shot and grit," which is commonly used in certain sections of the trade, is a misnomer and strongly recommends that its use be discontinued. The correct term is "chilled iron shot and grit."

The grades and sizes of chilled iron shot and grit covered by this standard have been designated 7, 8, 9, 10, 12, 15, 18, 22, 30 and 40. Screen sizes and tolerances are given to determine the particle size.

HOSE COUPLINGS FOR PETROL, OIL AND LUBRICANTS (¼IN TO 4IN NOMINAL SIZE)

No. 2464 : 1954. Price 7s. 6d. This is a new standard and applies to reduced bore couplings and adaptors for ¼in, 1in, 1¼in, 1½in, 2, 2½in, 3in and 4in hose, for use at pressures not exceeding 100 lb per square inch.

Two forms of screw threads have been specified for the couplings : Whitworth (B.S.P.) threads in accordance with B.S. 84 and American threads in accordance with A.S.A. specification B.33.1 (¼in to 2in), and with Federal Standard Stock Catalogue ZZ–H–466*b* (November, 1935) (2½in to 4in). Details of these American hose coupling threads are given in the appendices. These latter threads have been specified to ensure that the couplings connect with oil equipment screwed in accordance with API.STD. 5L and 6A. The couplings may be secured to the hose by clamps, by clips, or by other suitable means.

This standard deals with materials, dimensions, workmanship, marking and hydrostatic testing of the couplings. Illustrations of the couplings and full dimensional particulars are given.

ELECTRICALLY DRIVEN JIB CRANES MOUNTED ON A HIGH PEDESTAL OR PORTAL CARRIAGE (HIGH PEDESTAL OR PORTAL JIB CRANES)

No. 2452 : 1954. Price 7s. 6d. This forms one of a number of standards relating to jib cranes. It applies to electrically driven jib cranes, mounted on a high pedestal or portal carriage, of the level luffing, derricking or fixed radius types, used with hook or grab. It therefore covers the cranes often referred to as "wharf" or "dockside" cranes.

As with other British Standards for cranes, the object of this specification is to ensure reliability and safety without placing restrictions on the general design of the cranes or on the methods employed in their construction. Detailed requirements, including minimum factors of safety, are specified for the design of the crane structure and moving parts, and there is an appendix on the design of struts. Wire ropes, rope drums and pulleys, lifting hooks and grabbing are dealt with, and an appendix is included on customary forms of grab.

There are clauses on electric motors, brakes and electric braking, controllers, protective gear and switches, lighting and heaters, cables and wiring and earthing. Requirements are also specified for the performance testing of the completed crane.

Launches and Trial Trips

BRITISH GUNNER, oil tanker ; built by Harland and Wolff, Ltd., Govan, for the British Tanker Company, Ltd. ; length overall 518ft, length between perpendiculars 490ft, breadth moulded 65ft, depth moulded 36ft, deadweight 14,000 tons ; twenty-seven cargo oil compartments, two cargo pump rooms, two 125kW diesel-driven generators, one 50kW steam-driven generator ; Harland-B. and W. two-stroke, single-acting, opposed-piston diesel engine, six cylinders 620mm diameter by 1870mm stroke, 115 r.p.m., two single-ended multitubular boilers.

WHITBY ABBEY, cargo ship ; built by Hall, Russell and Co., Ltd., for Associated Humber Lines ; length between perpendiculars 240ft, breadth moulded 38ft 6in, depth moulded to shelter deck 21ft 6in, deadweight 1100 tons on 13ft 5in load draught ; three holds, six 7-ton and one 15-ton derricks, electric deck machinery ; Kincaid Polar diesel engine, 2100 b.h.p. at 220 r.p.m. Launch, April 30th.

GALLIENI, passenger and cargo liner ; built by the Chantiers et Ateliers de Provence for Des Messageries Maritimes ; length overall 378ft, length between perpendiculars 349ft 5in, breadth moulded 52ft 10in, depth to upper deck 29ft 3in, draught 19ft 8in, displacement 6900 tons, deadweight 4200 tons, service speed 14 knots ; cabin passengers 12, steerage passengers 350, deck passengers 20 ; two complete decks, three holds, nine derricks, including one of 30-ton capacity, seven watertight compartments, three 180kW diesel-driven generators ; Creusot-B. and W. diesel engine, five cylinders 620mm diameter by 1150mm stroke, 3000 b.h.p. Trial, April.

ANTEE, cargo ship and ore carrier ; built by the Chantiers Navals de Caen for the Société Navale Caennaise ; length overall 382ft 4in, length between perpendiculars 363ft 8in, breadth 49ft 3in, depth to main deck 24ft 8in, deadweight 5600 tons, four holds ; machinery built by the Ateliers et Chantiers de France, one Christiansen-Meyer compound steam engine, cylinder diameter 505mm and 1050mm by 1050mm stroke, 2000 h.p. at 95 r.p.m., steam supplied at 213 lb per square inch and 500 deg. Fah. by two oil-fired Proudhon-Capus boilers. Trial, April.

OLYMPIC VALOUR, oil tanker ; built by the Chantier et Ateliers de Saint Nazaire-Penhoët for the A. S. Onassis Company ; length overall 660ft, length between perpendiculars 631ft, breadth moulded 86ft 9in, depth 45ft., deadweight 31,500 tons, trial speed 16·7 knots ; thirty cargo oil tanks ; one set of Penhoët C.E.M.-Parsons double-reduction geared turbines of 15,000 s.h.p., 13,750 s.h.p. at 105 r.p.m. of propeller on trial, steam supplied at 640 lb per square inch and 850 deg. Fah. by two Foster-Wheeler boilers. Trial, May.

RECORDER, cable ship ; built by Swan, Hunter and Wigham Richardson, Ltd., Neptune Shipyard, for Cable and Wireless, Ltd. ; length overall 340ft 6in, breadth moulded 45ft, depth moulded to upper deck 27ft 3in, draught 18ft 6in, deadweight 2500 tons ; speed 12 knots ; two complete decks, three cylindrical cable tanks of 21,000 cubic feet total capacity, steam deck machinery, two 100kW steam-driven generators, one 100kW diesel-driven generator ; two sets of triple-expansion steam engines, cylinder diameter 15·5in by 26in by 44in, stroke 33in, 2200 i.h.p. at 108 r.p.m., steam supplied at 220 lb per square inch by two multitubular Scotch boilers. Launch, May 3rd.

STAHOLM, cargo ship ; built by Swan, Hunter and Wigham Richardson, Wallsend Shipyard, for A/S Havtank and A/S Hav., Oslo ; length between perpendiculars 430ft, breadth moulded 60ft 6in, depth moulded to upper deck 38ft 9in, deadweight 9000 tons on 25ft 6in draught, service speed 14·5 knots ; six passengers ; five cargo holds, derrick complement includes one to lift 25 tons, electric deck machinery, three 175kW diesel-driven generators ; Wallsend-Doxford two-stroke oil engine, five cylinders 670mm diameter by 2320mm combined stroke, 5000 b.h.p. at 108 r.p.m. Launch, May 3rd.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME AND PLACE *at which the meeting is to be held should be clearly stated.*

INSTITUTE OF METALS

Thurs., May 27th.—4, Grosvenor Gardens, London, S.W.1, "Lattice Defects and Energy Stored in Deformed Metals," W. Boas, 5.30 p.m.

INSTITUTE OF NAVIGATION

To-day, May 21st.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Visual Aids to Bad-Weather Approach," E. S. Calvert, 5 p.m.

Fri., June 4th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Exploring the Ocean Bed," Bruno Vailati, 8.15 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., May 25th.—ORDINARY MEETING FOLLOWED BY JOINT MEETING WITH INSTITUTION OF ELECTRICAL ENGINEERS : Great George Street, London, S.W.1, "Owen Falls, Uganda Hydro-Electric Development," C. R. Westlake, T. A. L. Paton and R. W. Mountain, 5.30 p.m.

Wed., May 26th.—Great George Street, London, S.W.1, "Owen Falls : Constructional Problems," D. P. Bertlin and Henry Olivier ; "A Note on 'Model Tests,'" C. M. White, 5.30 p.m.

Thurs., May 27th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Development and Utilisation of Hydro-Electric Power in Uganda," J. M. Stock and J. Lithgow, 5.30 p.m.

Tues., June 1st.—WORKS MEETING : Great George Street, Westminster, London, S.W.1, "Civil Engineering Construction Under Water," J. R. Malcolm and J. A. Lewis, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Tues., May 25th.—JOINT MEETING : Institution of Civil Engineers, Great George Street, London, S.W.1, "Owen Falls, Uganda Hydro-Electric Development," C. R. Westlake, T. A. L. Paton and R. W. Mountain, 5.30 p.m.

Wed., May 26th.—SUPPLY SECTION : Savoy Place, London, W.C.2, "Electrical Power Demand and Supply in the United States and the Role of Research in the Quarter Century Ahead," Philip Sporn, 5.30 p.m.——NORTH, SOUTH-EAST AND SOUTH-WEST SCOTLAND SUB-CENTRES : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting : Address by Chairman, C. H. A. Collyns, 7 p.m.

Thurs., May 27th.—ORDINARY MEETING : Savoy Place, London, W.C.2, "Development and Utilisation of Hydro-Electric Power in Uganda," J. M. Stock and J. Lithgow, 5.30 p.m.

Fri. and Sat., May 28th and 29th.—UTILIZATION SECTION : Summer Visit, Stratford-on-Avon.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, May 21st.—STOKE-ON-TRENT SECTION : Building Department, Technical College, Cauldon Place, Shelton, Stoke-on-Trent, "Metal Spraying," H. J. Plaster, 7.30 p.m.

Wed., May 26th.—SHREWSBURY SECTION : Technical College, Shrewsbury, "Cutting Tools, Their Development and Application," W. Castledine, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., May 27th.—11, Upper Belgrave Street, London, S.W.1 Annual General Meeting, 5.55 p.m.

IRON AND STEEL INSTITUTE

Wed. and Thurs., May 26th and 27th.—4, Grosvenor Gardens, London, S.W.1, Annual General Meeting, Morning Session on Wednesday in the Lecture Theatre, Royal Institution, Albemarle Street, London, W.1 : Hatfield Memorial Lecture, "Development in the Iron and Steel Industry in Great Britain During the Last Twenty-five Years," T. P. Colclough, 11.30 a.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., May 31st.—12, Great George Street, Westminster, London, S.W.1, Annual General Meeting, 5 p.m.

SOCIETY OF CHEMICAL INDUSTRY

To-day, May 21st.—CHEMICAL ENGINEERING GROUP : Hotel Rubens, Buckingham Palace Road, London, S.W.1, Annual General Meeting and Dinner, 6.45 p.m.

Tues. to Fri., June 1st to 4th.—CORROSION GROUP : Joint Conference with the Association Belge pour l'Etude, l'Essai et l'Emploi des Materiaux (A.B.E.M.), Brussels.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., May 25th.—MAIN MEETING : Manson House, Portland Place, London, W.1, Annual General Meeting, followed by a "Gadgets" evening, 6 p.m.